OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced Subsidiary GCE

Unit **F332:** Chemistry of Natural Resources

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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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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Annotations used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	separates marking points
not	answers which are not worthy of credit and which will CON a correct answer
ignore	statements which are irrelevant and will NOT 'CON' a correct answer
allow	answers that can be accepted
( )	words which are not essential to gain credit
__	underlined words must be present in answer to score a mark
ecf	error carried forward
AW	alternative wording (replaces the old 'or words to that effect')
ora	or reverse argument

Annotations used in scoris:

Annotation	Meaning
✓	correct response
×	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
I	Ignore
R	Reject

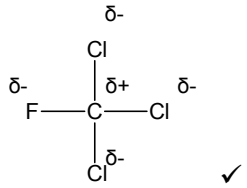
Subject-specific Marking Instructions that apply across the whole question paper to be included here.

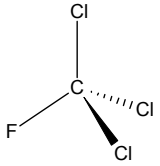
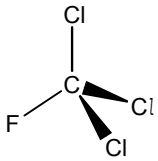
Please use ticks on the following questions: 1e, 2e, 5e

Question			Answer	Mark	Guidance
1	(a)		(Cyclo)alkene ✓ Ketone ✓	2	**ALLOW** C=C **OR** 'carbon-carbon double bond' **ALLOW** carbonyl Maximum of 1 mark if there is one incorrect answer, no marks if there are 2 incorrect answers
1	(b)		$C_{15}H_{22}O$ 15 Cs ✓ $H_{22}O$ ✓	2	C, H and O can be in any order (e.g.: $C_{15}OH_{22}$), but the answer must be a molecular formula to score both marks (e.g.: $C_{15}H_{21}OH$ only scores 1 for 15 Cs).
1	(c)	(i)	From: red / brown ✓ To: colourless ✓	2	Any combination of these colours but no other colour should be mentioned **DO NOT ALLOW** 'clear' **ALLOW** decolourised
1	(c)	(ii)	Answer to (b) + $2Br_2$ ✓ → Answer to (b) with Br_4 added ✓ e.g. these score two: $C_{15}H_{22}O + 2Br_2 \rightarrow C_{15}H_{22}OBr_4$ ✓✓ $C_{15}H_{22}O + 2Br_2 \rightarrow C_{15}Br_2H_{22}OBr_2$ ✓✓	2	C, H, O and Br can be in any order in the product formula, which does not have to be molecular. **DO NOT ALLOW** products with brackets (e.g.: $C_{15}H_{22}O(Br_2)_2$) **ALLOW** 1 mark for correctly balanced equation with 1 mole **OR** 3 moles Br_2, provided there is only one product. If completely correct answer (e.g.: $C_{15}H_{22}O + 2Br_2 \rightarrow C_{15}H_{22}OBr_4$) is given here, award both marks, even if a different molecular formula is given in (b).
1	(c)	(iii)	Electrophilic ✓ Addition ✓	2	**ALLOW** answers indicated in other ways, such as circling. Each additional underline **CON**s a mark

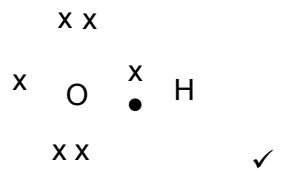
Question			Answer	Mark	Guidance
1	(d)	(i)	Phosphoric acid ✓ High temperature / pressure / 200°C or more / 50 atm or more ✓ **OR** Sulfuric acid ✓ Concentrated ✓	2	**IGNORE** concentration of phosphoric acid, water and inert catalyst supports such as silica. **ALLOW** phosphoric + sulfuric acid for first mark **IGNORE** water and any reaction conditions. <u>For either answer:</u> Second mark is awarded only if first mark is scored. Do **NOT** award the first mark if any other additional reagent is given (but condition mark can still be scored)
1	(d)	(ii)	Hydrogen (bonds) ✓	1	Do **NOT** award the mark if additional imfs are given
1	(d)	(iii)	Tertiary ✓	1	**DO NOT ALLOW** other answers (e.g.: one tertiary, one secondary)
1	(d)	(iv)	C to which OH is bonded is itself bonded to 3 other C **OR** no H on C to which OH is bonded **OR** 3 alkyl groups on C to which OH is bonded ✓	1	Can refer to R groups **ALLOW** 'it' or 'they' or 'alcohol (group)' for 'OH' **IGNORE** 'in the middle of chain' no ecf from **(iii)**

Question			Answer	Mark	Guidance
1	(e)		**For compound A:** Reaction mixture stays orange / no colour change ✓ (Tertiary) alcohol / OH groups are not oxidised by (dichromate (VI)) ions **OR** alcohol / OH groups don't react (with dichromate (VI)) ✓ **For compound B:** Reaction mixture changes from orange ✓ to green ✓ alcohol group on right hand carbon is oxidised / reacts to form aldehyde or carboxylic acid **OR** has primary alcohol group, which is oxidised / reacts to form aldehyde or carboxylic acid ✓	5	**Please use annotations on answer in appropriate place** Mark independently for each compound <u>For A:</u> **IGNORE** an incorrect colour if 'no colour change' or 'stays (wrong colour)' is also given **DO NOT ALLOW** 2nd mark if referring to secondary or primary alcohol <u>For B:</u> If answer states 'A stays orange, but B turns green' award both colour marks for B Do **NOT** award this mark if the answer states that the alcohol group is secondary
			Total	**20**	

Question			Answer	Mark	Guidance
2	(a)		2,2-dichloro-1,1,1-trifluoroethane dichlorotrifluoroethane ✓ 2,2 and 1,1,1 ✓	2	**IGNORE** commas and dashes Allow minor spelling errors, such as 'flouro' The 1st mark is for correct alphabetical order, the 2nd for appropriate numbers **ALLOW** 1,1-dichloro-2,2,2-trifluoroethane for 2 marks **ALLOW** 2,2,2-trifluoro-1,1-dichloroethane **OR** 1,1,1-trifluoro-2,2-dichloroethane for 1 mark
2	(b)		**D** is obtained from crude oil (but the others are manufactured) / less processing needed for D (ora) **OR** others contain halogens (D doesn't) (ora) ✓	1	
2	(c)		It is gas (at room temperature) ✓	1	**ALLOW** boils below room temperature **ALLOW** 'flammable'
2	(d)	(i)	 ✓	1	Must show all charges, not just δ- on one C*l*.
2	(d)	(ii)	Mention of <u>electronegativity / electronegativities</u> / <u>electronegative</u> ✓ Fluorine and chlorine more electronegative than carbon (ora) ✓	2	Electronegativity / electronegativities / electronegative (must be one word, not hyphen, unless word split across lines) must be correctly spelled **once** in the answer for first mark **ALLOW** 'C*l* and F have a greater pull on bonding electrons' for 1 mark Answer needs to be a comparison with carbon (e.g.: C*l* and F are highly electronegative' does not score the second mark)

Question			Answer	Mark	Guidance
2	(d)	(iii)	 **OR**  ✓	1	**ALLOW** other 3-D representations of the molecule **ALLOW** fluorine in any position Diagram needs to be as shown on the left **OR** one bond in the plane, with two going into the plane of the page and one coming out (or vice versa) If two bonds are shown in the same plane, they must be next to each other
2	(d)	(iv)	C-F bond and C-C*l* bond have different polarities ✓ (Molecule is) polar because: the charges/dipoles do not balance **OR** cancel out **OR** centre of +ve and –ve charges don't coincide **OR** greater δ- on the F side of the molecule *AW* ✓	2	**ALLOW** '(partial) charge on F different to that on C*l*' **OR** 'F different electronegativity to C*l*' **ALLOW** 'polar because molecule is asymmetric' Mark independently **ALLOW** a maximum of 1 mark for 'molecule is non-polar' if also say 'because the charges/dipoles balance/cancel out **OR** centre of +ve and –ve charges coincide'

Question			Answer	Mark	Guidance
2	(e)		1. Bonds too strong to be broken in the troposphere **OR** (there is) too little energy / frequency of radiation too low in the troposphere to: break bonds / cause photodissociation / cause homolytic fission **OR** high energy / frequency radiation needed to break bonds not present in troposphere ✓ 2. in the stratosphere uv breaks bonds **OR** in the stratosphere uv causes photodissociation / homolytic fission ✓ 3. (to form) chlorine atoms / chlorine radicals / C*l* ✓ 4. radicals catalyse the breakdown of ozone *AW* ✓ **QWC**: *for connection of ideas: Link made between breaking down of molecule and either production of C*l *radicals or radicals catalysing ozone breakdown* ✓	4 1	**Please use annotations on answer in appropriate place** 1. **DO NOT ALLOW** just 'the molecule is not broken down' **OR** 'the molecule does not react' **DO NOT ALLOW** 'the right amount of energy is not present in the troposphere' 2. **DO NOT ALLOW** 'high energy' for uv. **ALLOW** 'In the stratosphere uv breaks down the molecule' 3. **DO NOT ALLOW** mark if chlorine radicals **and** fluorine radicals are formed. Can be scored from equation: $CFCl_3 \rightarrow CF_3 + Cl$ 4. Answer **MUST** have the idea of recycling or regenerating the radical. Can be shown in equations. Award mark even if radicals other than C*l* given. Please indicate qwc mark using red cross or green tick on to the right of the pencil icon on the answer screen. If mp2 and either 3 or 4 are gained, award QWC

Question			Answer	Mark	Guidance
2	(f)		It filters / screens / absorbs / removes / prevents / shields / blocks / stops (*AW*) any type of uv ✓ (radiation) of high energy / high frequency / UVB / UVC / value in range 10^{14} - 10^{16} Hz / short wavelength / value in range 200 – 320 nm ✓ (which could otherwise cause) skin cancer / damage to DNA / damage to skin / damage to eyes / damage to immune system / cell mutation / affects crops ✓	3	**IGNORE** 'protects us from uv' **IGNORE** high intensity radiation **ALLOW** sunburn
2	(g)		 ✓	1	Any two different symbols can be used to represent the electrons Candidate can draw circles for electron shells It **MUST** be clear that a pair of electrons is being shared between the H and the O **IGNORE** inner shell electrons **DO NOT ALLOW** diagram showing a charge
2	(h)	(i)	(463/ 6.02 x 10^{23}) x 1000 and evaluate (= 7.691/ 7.69 / 7.7 x 10^{-19} J) ✓✓ **OR** one mark for **EITHER**: 463 x 1000 (=463000) **OR** 463/ 6.02 x 10^{23} and evaluate (=7.691/ 7.69 / 7.7 x 10^{-22})	2	One mark is for converting 463 from kJ to J i.e.: multiply by 1000 Other mark is for dividing by 6.02x10^{23} (the Avogadro constant) To get second mark, there must be a correct evaluation **IGNORE** sig figs A completely correct answer on its own scores both marks

Question			Answer	Mark	Guidance
2	(h)	(ii)	Answer to (h)(i) / 6.63 x 10^{-34} ✓ = 1.16 x 10^{15} ✓ Units Hz **OR** s^{-1} ✓	3	**DO NOT ALLOW** second mark for evaluating any other expression e.g.: Answer to (e) (i) x 6.63 x 10^{-34} unless: the sole error is a mis-copy of one of the number values (e.g.: answer to (h)(i) / 6.36 x 10^{-34} doesn't score 1st mark, but gets 2nd) **ALLOW** hz A completely correct answer on its own scores both marks
2	(h)	(iii)	Homolytic (fission) / homolysis ✓	1	Ignore 'photochemical dissociation'
2	(h)	(iv)	The frequency (of radiation / uv) is not high enough (to break the bond) *AW* **OR** The energy of (radiation / uv) is not enough (to break the bond) *AW* ✓	1	Ignore 'intensity' and 'light' **ALLOW** 'uv / high energy / high frequency radiation needed is not present (in troposphere)' **OR** has been absorbed (in stratosphere)
			Total	**26**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td>Cl_2 (g) + 2Br^- (aq) → 2Cl^- (aq) + Br_2 (g)

Equation ✓
State symbols ✓</td><td>2</td><td>ALLOW multiples

Award state symbols mark if equation is not fully correct (e.g.: has Br instead of Br_2), as long as there are only 2 reactants and 2 products</td></tr>
<tr><td>3</td><td>(b)</td><td>(i)</td><td><table><tr><th>element</th><th>initial oxidation state</th><th>final oxidation state</th><th>marks</th></tr><tr><td>Br</td><td>0</td><td>-1</td><td>✓</td></tr><tr><td>S</td><td>+4</td><td>+6</td><td>✓✓</td></tr></table></td><td>3</td><td>One mark for both Br oxidation states
One mark for each correct oxidation state for S

ALLOW 2 marks if <u>all</u> number values are correct, but sign is to the right of the number (ie: 0, 1-, 4+, 6+)
IGNORE +/- on 0 for Br_2
ALLOW 1 mark for S if answer gives 4 <u>and</u> 6, but no +</td></tr>
<tr><td>3</td><td>(b)</td><td>(ii)</td><td>SO_2 ✓

The oxidation state of the S (in SO_2) increases
OR
the SO_2 reduces the oxidation state of the Br (in Br_2) ✓</td><td>2</td><td>ALLOW sulphur dioxide

ALLOW ‘S / SO_2 is oxidised’ OR ‘SO_2 loses / donates electrons’
IGNORE sulphur / S has lost electrons
ALLOW 'Br_2 is reduced' OR ‘bromine gains electrons’
ALLOW ‘number’ for ‘state’
2nd mark can be scored if S is incorrectly given as the reducing agent, otherwise 2nd mark depends on first</td></tr>
<tr><td>3</td><td>(c)</td><td></td><td>Cream / off-white ✓
precipitate / solid ✓</td><td>2</td><td>IGNORE initial colours and changes of colour on standing</td></tr>
<tr><td>3</td><td>(d)</td><td>(i)</td><td>(32.6 x 0.0200 /1000 =) 6.52×10^{-4} ✓</td><td>1</td><td>Working not needed and does not score on its own</td></tr>
<tr><td>3</td><td>(d)</td><td>(ii)</td><td>Answer to (i) (6.52×10^{-4}) ✓</td><td>1</td><td></td></tr>
</table>

Question			Answer	Mark	Guidance
3	(d)	(iii)	Answer to (ii) / 25.0 ✓ x 1000 and correct evaluation (= 2.608 x 10^{-2}) ✓ **OR** Answer to (ii) x1000 ✓ divide by 25 and evaluate ✓ 0.0261 / 2.61 x 10^{-2} to 3s.f. ✓	3	The answer on the line must come from the answer to (ii). Hence 0.0261 / 2.61 x 10^{-2} is not necessarily the correct response **ALLOW** sf mark for any 3 sig fig answer that follows from any correctly evaluated calculation
			Total	**14**	

Question			Answer	Mark	Guidance
4	(a)		Rate of forward reaction = rate of back reaction **OR** reactants and products are formed at the same rate ✓ Concentrations of (reactants and products) remain constant / stay the same **OR** closed system ✓	2	**DO NOT ALLOW** 'concentrations of reactants and products **are** the same/equal'. If this has been stated, only 1 mark can be scored, even if the answer also states 'closed system'
4	(b)		Nanoparticles will provide a larger / greater / more / surface area of catalyst (in contact with the reactants) *AW* ✓ (Allowing) more collisions per unit time (*AW*) / more frequent collisions **OR** more particles can bond to the surface per unit of time ✓	2	Must be comparative. Not just 'large' **ALLOW** 'higher' **DO NOT ALLOW** just 'more collisions' or 'more chance of collisions' Mark independently
4	(c)		Minimum energy *AW* ✓ (Energy) for colliding particles to react / for a collision to cause a reaction **OR** (Energy) for a successful / effective collision *AW* ✓	2	**DO NOT ALLOW** references to reactants colliding
4	(d)	(i)	Reaction rate increases ✓ Particles are closer together (*AW*) **OR** concentration increases / more particles per unit volume ✓ so collide more frequently / more collisions per unit time ✓	3	**IGNORE** references to equilibrium **ALLOW** 'more particles in the same area' **DO NOT ALLOW** particles are more compressed **DO NOT ALLOW** just 'more collisions' or 'more chance of collisions' **IGNORE** comments on particle speed and energy or yield

Question			Answer	Mark	Guidance
4	(d)	(ii)	(equilibrium yield) decreases **OR** less products / CO / H_2 **OR** yield of reactants increases **OR** more CH_4 / H_2O forms ✓ equilibrium (position) moves: to oppose the change / to the left / in backwards direction / towards reactants ✓ because fewer moles/molecules/particles on left-hand-side/ reactants side (ora) ✓	3	**IGNORE** references to rate. **ALLOW** 'yield of reactants increases' / 'more reactants' / 'more CH_4 **OR** H_2O' Mark independently **DO NOT ALLOW** atoms instead of 'molecules
4	(d)	(iii)	(Yield would) increase **OR** more products / CO / H_2 **OR** yield of reactants decreases **OR** less CH_4 / H_2O forms ✓ equilibrium (position) moves: to oppose the change / to the right / in forwards direction / towards products ✓ in the endothermic direction / forward reaction is endothermic ✓	3	**IGNORE** references to rate. **ALLOW** 'yield of reactants decreases' / 'less reactants' / 'less CH_4 **OR** H_2O'
4	(e)	(i)	Growing rice / livestock farming / making silage *AW* ✓	1	Must be an agricultural activity (e.g.: cows belching does not score)
4	(e)	(ii)	(More methane means) more radiation is absorbed **OR** (More methane means) more bonds vibrate ✓ This energy is transferred to KE **and** that increases atmospheric temperature / warms atmosphere **OR** molecules radiate/emit ir **and** that warms Earth/atmosphere ✓	2	**DO NOT ALLOW** mark if answer refers to absorbing radiation other than ir **DO NOT ALLOW** bonds vibrate more Both points needed for mark here Idea of transfer needed

Question			Answer	Mark	Guidance
4	(e)	(iii)	21% = 210000 ppm ✓ 210000/1.8 = 1.2 x 10^5 times more ✓ **OR** 1.8ppm = 1.8 x 10^{-4}% ✓ 21/1.8x10^{-4} = 1.2 x 10^5 / 1.167 x 10^5 / 116667 times more ✓	2	**ALLOW** 2 or more sf **ALLOW** ecf from incorrect conversion of units for second mark **ALLOW** 1 mark for 21/1.8 correctly evaluated
			Total	**20**	

Question			Answer	Mark	Guidance
5	(a)		One product / no molecule eliminated ✓ (forms) a long chain **OR** many molecules/monomers joined/bonded ✓ Poly(chloroethene) / PVC / poly(propene) ✓	3	
5	(b)		Addition ✓	1	**IGNORE** types of addition (e.g.: electrophilic) except for 'polymerisation', which does not score
5	(c)	(i)	***Any three from:*** 1. Bonds absorb ir radiation ✓ 2. (Absorbtion of ir) of a particular (range of) frequencies / wavelengths / wavenumbers *AW* ✓ 3. (causing) vibration / bending / stretching ✓ 4. Spectrum shows peaks / troughs / regions / frequencies / wavenumbers where absorption has occurred *AW* ✓ ***and*** No peaks (*AW*) for bonds involving atoms other than C and H, (such as O-H or C=O) ✓	3 1	 2. **DO NOT ALLOW** 'particular amount of energy' 3. **ALLOW** increase in vibrational energy **IGNORE** references to C=C **ALLOW** absorptions corresponding to C-C / C-H bonds would be present in the spectrum **ALLOW** there are peaks corresponding to C-C / C-H bonds (Candidate could quote relevant wavenumber ranges: C-H 2850 – 2950 (cm^{-1}))
5	(c)	(ii)	Peak for a C=O bond ✓ At 1705-1725 (cm^{-1}) ✓	2	**ALLOW** carbonyl / ketone peak **ALLOW** arene ✓ gives peaks in the region 1450 – 1650 (cm^{-1}) / 3000 – 3100 (cm^{-1}) ✓ **ALLOW** 1 mark if answer includes one correct bond and wavenumber range and one incorrect one (ignore C=C in arenes)
5	(d)	(i)	Radicals formed from non-radicals / molecules *AW* ✓	1	**DO NOT ALLOW** just 'reaction that forms a radical'

Question			Answer	Mark	Guidance
5	(d)	(ii)	Movement of one/an/a single electron *AW* ✓	1	**IGNORE** 'lone' or 'unpaired' **ALLOW** 'transfer of one electron'
5	(d)	(iii)	$Ra(CH_2)_m\bullet + \bullet(CH_2)_nRa \rightarrow Ra(CH_2)_m(CH_2)_nRa$	1	Dots on radicals not essential

Question			Answer	Mark	Guidance
5	(e)		***Six from:*** 1. Electron movements *AW* ✓ 2. cause uneven distribution of charge *AW* ✓ 3. A dipole is induced in a neighbouring molecule, leading to attraction ✓ 4. LDPE has branches **OR** HDPE does not have branches / has straight chains ✓ 5. LDPE chains cannot pack closely / have less surface contact (ora) ✓ 6. which leads to (intermolecular) bonds / attractive forces being weaker between LDPE chains (ora) ✓ 7. so less energy/force is needed to break (intermolecular) bonds in LDPE (ora) ✓ 8. Chains of LDPE slide over each other more easily (ora) **OR** less force is needed to make LDPE chains slide over each other (ora) ✓ ***QWC*** *for showing clearly that the process from mp3 follows from the process in mp2* ***OR*** *that the process from mp6 follows from the process in mp5* ***OR*** *that the process from mp7 or mp8 follows from mp6* ✓	6 1 **Please use annotations on answer in appropriate place** Please indicate qwc mark using red cross or green tick on to the right of the pencil icon on the answer screen	**ALLOW** answers referring to intermolecular forces rather than bonds 1. **NOT** electron density changes or electrons are orbiting/ spinning/circling for movement 2. Examples of alternative wording for mp 2 are: ‘<u>partial</u> positive and/or negative charge’ or ‘δ+ and/or δ-’ or a diagram showing these (on a molecule or atom, not either end of a bond) 3. needs both parts to score (i.e.: induces dipole in neighbour **AND** attracts it). **DO NOT ALLOW** just forming a bond as attraction 5. **DO NOT ALLOW** just ‘fit together easily / more easily’ 6. **ALLOW** less/fewer intermolecular bonds / attractive forces can form between LDPE chains (ora)
			Total	**20**	

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