OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced Subsidiary GCE

Unit **F331:** Chemistry for Life

Mark Scheme for January 2013

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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotations

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
	benefit of the doubt
	benefit of the doubt **not** given
	error carried forward
	information omitted
	Ignore
	Reject

Question			Answer	Marks	Guidance
1	(a)	(i)	measures tendency to auto-ignite/pre-ignite/knock/pink ✓ More efficient combustion **OR** reduces risk of/stops damage to engine **OR** higher octane number means less knocking/pinking/autoignition and etc ✓	2	Need to see likelihood of autoignition Ignore references to two sparks/explosions **ALLOW** improves engine performance **ALLOW** higher octane number means less knocking **ALLOW** knocking less likely but **NOT** no knocking **NB** prevents knocking **does not CON** another correct answer
		(ii)	cyclic / cycloalkane / cycloalkene / ring / arene / branched alk**e**ne ✓	1	**ALLOW** aromatic/benzene **NOT** branched alk**a**ne
	(b)	(i)	heterogeneous – catalyst and reactant(s)/hydrocarbons in different phase/state ✓ catalyst speeds up reaction by providing a route/pathway/mechanism of lower activation enthalpy/energy **OR** speeds up a reaction but can be recovered unchanged at the end/can be regenerated/is not used up ✓	2	**ALLOW** catalyst solid, reactants gases/liquids **DO NOT ALLOW** 'substance instead of reactants' **DO NOT ALLOW** 'chemical state' **DO NOT ALLOW** 'speeds up reaction' without qualification **IGNORE** reduces activation energy **NOT** 'not involved' **NOT** 'not changed' on own or remaining unchanged
		(ii)	Poison/lead (very) strongly/irreversibly adsorbed **OR** won't come off **OR** stays on ✓ reactions cannot happen/prevents reactants getting to surface/blocks surface/other molecules can't attach ✓	2	**DO NOT ALLOW** other suggested poisons eg S **DO NOT ALLOW** a**b**sorbed Vague comments e.g. 'catalyst prevented from working' do not score Mark independently
		(iii)	only produces water (on combustion/burning) **OR** does not produce CO_2 / CO / no particulates / C / SO_2 ✓	1	**NOT** just a general comment about pollution/harmful gases **CON** references to NO_x **DO NOT ALLOW** less/little pollutants **IGNORE** references to renewable/plentiful/energy density

Question			Answer	Marks	Guidance
		(iv)	energy in / endothermic to break bonds ✓ energy released / given out / exothermic when bonds form ✓ less energy given out than taken in ✓	3	statement 'more energy needed to break bonds than make' only scores one (first) mark Has to be **bond** formation NOT **product** formation **NOT** ecf on first two statements References to <u>fewer/more</u> bonds **CON**s final mark
	(c)		First marking point: idea of splitting or breaking (larger) hydrocarbon/molecule break/split AW ✓ Remaining two marking points for possible types of molecules formed, but <u>to score both points smaller/shorter must be mentioned at least once</u> Any <u>two</u> from: ✓ ✓ smaller/shorter } alkane/saturated (compound) alkene/alkyene/unsaturated (compound) cycloalkane	3	Reference to **between** molecules is a **CON** on first mark **IGNORE** references to branching **DO NOT ALLOW** arene/aromatic molecule **ALLOW** references to **C=C** etc. **DO NOT ALLOW simply** (shorter) hydrocarbon/molecule
			Total	**14**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>Isotope</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th></tr>
<tr><td>Helium-3</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>Helium-4</td><td>2</td><td>2</td><td>2</td></tr>
</table>
✓</td><td>1</td><td>All must be correct</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Beta/β decay ✓

proton/atomic number (in daughter product) goes up (by one) OR neutron converted to proton ✓</td><td>2</td><td>DO NOT ALLOW no change in mass number (of daughter product) (this would be the case with just gamma emission)
If alpha decay score 0
DO NOT ALLOW no change to A_r
DO NOT ALLOW un-annotated equation as explanation
IGNORE references to electrons</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>$^{1}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He$ ✓</td><td>1</td><td><u>Any</u> of numbers on right of symbol scores zero
IGNORE any reference (symbol) to gamma decay
ALLOW ‘=’ instead of ‘→’</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Overcome repulsion ✓

between (positively charged) <u>nuclei</u> OR
to join the two nuclei ✓</td><td>2</td><td>Mark separately

IGNORE references to electrons
NOT ions</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>black/dark lines/bands ✓
bright/coloured/solar/<u>visible</u> spectrum background ✓</td><td>2</td><td>IGNORE references to lines getting closer
Description of emission spectra scores zero i.e. no ecf
If word spectrum is used it must be qualified</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Radiation/light/energy absorbed causes <u>electron(s)</u> to move <u>up</u> (electronic energy levels) ✓

energy levels unique/specific/different (to element) ✓

energy absorbed related to frequency (of line produced) OR (Δ) E = hf OR ΔE = hv ✓</td><td>3</td><td>arrow up on a diagram scores first marking point
ALLOW shells

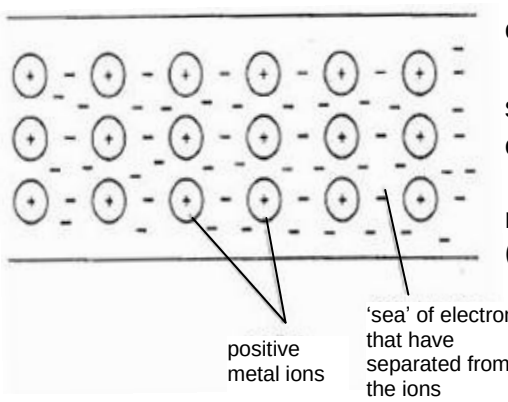
ALLOW ‘each element has its own/different levels’</td></tr>
</table>

Question			Answer	Marks	Guidance
	(d)		sample ionised ✓ all ions are accelerated (in electric field/plates) ✓ to the <u>same **kinetic** energy</u> ✓ move into drift/flight region ✓ heavier ions/isotopes move more slowly (across to detector) (ora) AW ✓	5	**ALLOW** 'ions are made', negative ions **CON** **DO NOT ALLOW** 'accelerated by magnetic/ electromagnetic field' for this mark **CON** This statement scores 2nd and 3rd marking points i.e. a statement 'ions are given the <u>same kinetic energy</u>' scores both 2nd and 3rd marking points **SPG (kinetic)** must be spelt correctly to score this marking point, but not a separate mark**; if not scored X on pencil** At correct point in sequence, eg ionised > drift region scores this mark BUT ionised>drift region>accelerated does not score **IGNORE** references to molecules/atoms for last marking point **IGNORE** references to how detector measures abundance References to larger/smaller ions should be ignored
			Total	**16**	

Question			Answer	Marks	Guidance
3	(a)		**Any one of:** increases octane number/rating less knocking/auto ignition/pre-ignition reduces CO ✓	1	**ALLOW** combustion more complete / less incomplete **ALLOW** complete combustion **ALLOW** 'less oxygen to burn' / 'completely combust' / no CO
	(b)	(i)	C_8H_{16} ✓	1	Accept $H_{16}C_8$ **NOT** "h"
		(ii)	M_r of C_8H_{16} = 112 ✓ Moles in one kg = 1000/112 = 8.93 kJ per kg = 8.93 x 5300 = 47329 ✓ (depending on rounding) two sf's (47000/4.7 x 10^4) ✓ **correct answer is 3 marks**	3	**ecf** on wrong formula in (i) **ecf** on wrong M_r above **ALLOW** sig fig mark from any correct calculation **NB a different approach** to solving the problem is: energy per gram = 5300/112 then kJ per kg = 5300/112 x 1000 **IGNORE** sign of answer
	(c)	(i)	(molecules with) same molecular formula/same number and type of atoms but different structural formulae/arrangement of atoms AW ✓	1	**DO NOT ALLOW** 'different shape'
		(ii)	Bond angle between 115–125 ✓ 3 areas of <u>electron</u> density/sets or groups (bonding) <u>electrons</u> ✓ electrons <u>repel</u> ✓ as far as possible/minimise electron repulsion ✓	4	 **IGNORE** references to central carbon/shape/angle 3 bonding pairs/areas **CON**'s the second mark **NOT** 'as much as possible' unless qualified with minimise etc. **NOT** 'bonds repel' but 'bonds made of electrons and repel is fine' **NOT** atoms repel As far as possible **to** minimise (electron) repulsion will score 3rd and 4th mark

Question			Answer	Marks	Guidance
		(iii)	smaller **OR** a given angle of range 104–112 ✓ because 4/more areas (repel and gives 109.5^0) ✓	2	**No ecf from last question** Do not penalise failure to mention 'of electrons' *Mark separately*
	(d)	(i)	200 x 4.18 x 25 = **20900** ✓	1	**ALLOW** 21000
		(ii)	mass of <u>fuel/hydrocarbon/it</u> (burnt) ✓	1	**ALLOW** volume <u>and</u> density Assume 'it' refers to the fuel **DO NOT ALLOW** moles/amount
		(iii)	Same number of bonds broken and formed/made ✓ Same type of bonds broken and formed/made ✓	2	**DO NOT ALLOW** similar **ALLOW** 'same bonds broken and formed' for this mark same number and type of bonds broken scores 1 same number and type of bonds formed scores 1
		(iv)	One of: incomplete combustion evaporation of fuel/loss of fuel vapour non-standard conditions ✓	1	**IGNORE** heat loss to container **NOT** average bond enthalpies
			Total	**17**	

Question			Answer	Marks	Guidance
4	(a)	(i)	$4Ce + 3O_2 \rightarrow 2Ce_2O_3$ ✓	1	**ALLOW** 2:1½:1 or multiples **IGNORE** state symbols **NOT** $2Ce_2$
		(ii)	moles Ce= 81.4 ÷ 140.1 = 0.58 moles O=18.6 ÷ 16.0 = 1.16 ✓ gives CeO_2 ✓	2	**ALLOW** one mark for a correct whole number ratio based on wrong calculation e.g. using atomic number (this would give Ce_3O_5) CeO_2 alone scores 1 mark – **"show your working"** Not just any wrong calculation
	(b)	(i)	covalent network **OR** giant covalent (molecule) ✓	1	**ALLOW** covalent lattice
		(ii)	 ✓	1	**All** outer electrons must be shown Bonding electrons can be in any order or horizontal 'Pairing' not essential for lone pairs **IGNORE** shape Check for dot cross conformity
		(iii)	no double bonds in SiO_2 **OR** silicon forms four/more than two/single bonds to oxygen ✓	1	**NOT** carbon dioxide contains a double bond Look out for **CON** in any structure suggested **e.g.** lone pairs on Si **e.g.** no lone pairs on oxygen **e.g.** more lone pairs on each atom **ALLOW** each oxygen bonded to two Si atoms

Question			Answer	Marks	Guidance
	(c)		 cations/positive ions ✓ sea of /delocalised/ electrons ✓ regular array (at least six ions) ✓	3	maximum 2 marks if no diagram drawn protons/nuclei/positive metal atoms/particles **CONS** first mp **IGNORE** free/pool/cloud/moving of electrons. **ALLOW** ring around all the ions labelled 'delocalised/sea of electrons' **CON** if first two marking points are labelled to incorrect parts of diagram If **metal given** ignore type 3rd marking point from diagram (need not have label) structure = at least two rows; need not be 'close packed', circles may touch
	(d)	(i)	*First mark for <u>idea</u> that gaps left because without them some known elements did not fit in groups* (without the gap) properties of known elements did not fit ✓ *Second mark for new elements discovered which did fit in gaps (with appropriate props)* element/scandium discovered fitting in gap (with appropriate properties) ✓	2	**ALLOW** to place elements with similar properties in the correct column/group **ALLOW** 'he suggested there were elements yet to be discovered' **DO NOT ALLOW** 'elements were discovered' on own

Question			Answer	Marks	Guidance
		(ii)	atomic/proton number/number of protons ✓	1	**DO NOT ALLOW** electronic structure
		(iii)	electron structure/configuration/arrangement ✓	1	**ALLOW** number of electrons in outer shell **ALLOW** number of electron shells / electron shells **IGNORE** any references to protons / energy shells **ALLOW** reference to electron shells e.g. number e.g. number of shells is period number
			Total	**13**	

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