Green Chemistry

Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Green Chemistry
Booklet	Mark Scheme

Time Allowed: **41 minutes**

Score: **/34**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Mark
1	D	**(1)**
	Incorrect answers A – incorrect percentage B - incorrect percentage C - incorrect percentage	

Question Number	Correct Answer	Reject	Mark
2(a)	C		1

Question Number	Correct Answer	Reject	Mark
2(b)	D		1

Question Number	Correct Answer	Reject	Mark
3	D		1

Question Number	Correct Answer	Reject	Mark
4	B		1

Question Number	Correct Answer	Reject	Mark
5	D		1

Question Number	Correct Answer	Reject	Mark
6	C		1

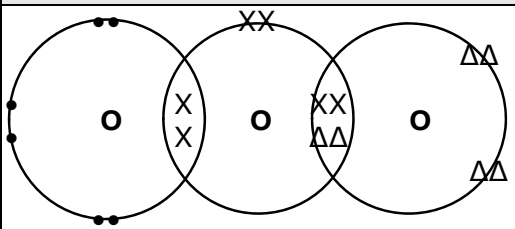
Question Number	Correct Answer	Reject	Mark
7	C		1

Question Number	Correct Answer	Reject	Mark
8	D		**1**

Question Number	Correct Answer	Reject	Mark
9	D		**1**

Question Number	Correct Answer	Reject	Mark
10	B		**1**

Question Number	Correct Answer	Reject	Mark
11	D		**1**

Question Number	Acceptable Answers	Reject	Mark
12(a)(i)	 Eight electrons around each end oxygen of which six must be of the same symbol (1) Rest of electrons correct (1) Triangles and dots can be drawn the other way round Non-bonding electrons can be as pairs or separate		2

Question Number	Acceptable Answers	Reject	Mark
12(a)(ii)	There are three areas of electron density/regions of negative charge/groups of electrons (and not two) around (the central oxygen) OR Non-bonding/lone pair (of electrons) on the **central / middle / centre oxygen atom** ALLOW There are more than two areas of electron density/regions of negative charge/groups of electrons on the **central / middle / centre oxygen atom**	Mention of other atoms Lone pair**s**	1

Question Number	Acceptable Answers	Reject	Mark
12(a)(iii)	(Increased risk of) malignant melanoma/ basal cell carcinoma(s) / (Increased risk of) **skin** cancer/DNA breakdown/mutation Retinal/eye damage/snow blindness IGNORE references to sunburn IGNORE just cancer	Reference to global warming	1

Question Number	Acceptable Answers	Reject	Mark
12(a)(iv)	(UV) is high(er) energy /high(er) frequency /short(er) wavelength OR (UV) breaks covalent bonds OR produces free radicals/ions OR Reverse answers for IR IGNORE more penetrating	Long(er) wavelength Low(er)energy/frequency	1

Question Number	Acceptable Answers	Reject	Mark
12(a)(v)	Species / molecule / atom/particles with an unpaired electron	unpaired electron**s** Just 'single electron' 'lone electron' 'free electron' 'one electron'	1

Question Number	Acceptable Answers	Reject	Mark
12(a)(vi)	**M independently** Dots must be shown on either second NO or on one of the NO_2 molecules **First mark** $(NO^{\bullet} + O_3 \rightarrow)\ NO_2{}^{\bullet} + O_2$ (1) **Second mark** $NO_2{}^{\bullet} + O_3 \rightarrow NO^{\bullet} + 2O_2$ OR BOTH $O_3 \rightarrow O^{\bullet} + O_2$ AND $NO_2{}^{\bullet} + O^{\bullet} \rightarrow NO^{\bullet} + O_2$ (1) **Third mark** $2O_3 \rightarrow 3O_2$ (1) Allow multiples		3

Question Number	Acceptable Answers	Reject	Mark
12(a)(vii)	**Catalyst** IGNORE anything else including catalytic converter **Comment** The word catalyst can be awarded the mark if shown in a(vi)		1

Question Number	Acceptable Answers	Reject	Mark
12(a)(viii)	They breakdown/react/dissolves (in the lower atmosphere before they rise to the ozone layer)	Reference to catalytic converter	1

Question Number	Acceptable Answers	Reject	Mark
12(b)(i)	It has polar bonds OR $O^{\delta-} = C^{\delta+} = O^{\delta-}$ (1) (Absorption results in) change in dipole moment / (asymmetric) **bond** vibration/stretching/bending OR change in (bond/molecule) polarity (1) IGNORE Reference to global warming process	Polar molecule Bonds break	2

Question Number	Acceptable Answers	Reject	Mark
12(b)(ii)	Nitrogen/N_2 /Oxygen/O_2 / Argon/Ar	N/O Other noble gases Hydrogen/H/H_2 Water vapour	1

Question Number	Acceptable Answers	Reject	Mark
12(b)(iii)	CFCs absorb/trap **infrared** radiation **very effectively / strongly** ALLOW heat /IR for infrared OR High greenhouse factor/global warming potential OR (Very) polar C-F bonds	Depletion of ozone layer	1

Question Number	Acceptable Answers	Reject	Mark
12(b)(iv)	(CFCs) No longer being released in the atmosphere/ less used/concentration decreasing/ amount reduced OR Banned from use/production OR CFCs replaced by HCFCs / HFCs/ Propane / Butane IGNORE More carbon dioxide	…Methane	1

Question Number	Acceptable Answers	Reject	Mark
12(b)(v)	**Any two from** Anthropogenic change is man-made (1) Water vapour is always present naturally OR Water vapour present from natural sources OR Water vapour due to the water cycle/ named processes (1) The levels of water vapour have kept relatively constant (over the recent centuries) (1) Can't control natural water vapour emissions (1) COMMENT Do not penalise 'water vapour has less effect on global warming' in this question Do not penalise 'water vapour is not produced by humans' in this question		2

Question Number	Acceptable Answers	Reject	Mark
12(b)(vi)	**MP1** Carbon neutrality is where the CO_2 released on combustion is equal to the CO_2 absorbed on formation of the fuel/plant ALLOW Amount of carbon dioxide taken/reacted in equals amount given out/produced OR No net increase in atmospheric carbon dioxide (1) **MP2** CO_2 (from fossil fuels) is likely to be released from transport/production of biofuel/production of fertiliser/processing of the biofuel ALLOW Biofuels are a blend including fossil fuels (1) IGNORE Reference to 'waste'	Just 'carbon'	2

Question Number	Acceptable Answers	Reject	Mark
12(b)(vii)	**y two from:** Use catalysts/enzymes (to reduce energy consumption) (1) Use microwave energy (which is more efficient) (1) Improve thermal insulation (1) Use heat exchangers/heat recovery (1) Reduce waste/recycle (bi-)products (1) Use renewable resources in its processes (1) Use high atom economy processes (1) Use nuclear power/renewable energy sources/use wind power/use solar power/use fuel cells (1) Use carbon capture and storage methods (1) **Note** Credit two different storage/capture methods separately for both marks eg sending carbon dioxide back to replace north sea gas under the sea (1) neutralising with scrubbers, absorbing with alkali/limestone etc (1) **Comment** Send any unexpected well-reasoned points to your TL IGNORE Use reactions needing lower temperatures Plant more trees Reduce car use Use of hydrogen as a fuel	High pressure	2

TOTAL FOR QUESTION 12 = 22 MARKS