

Green Chemistry

Question Paper

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

Time Allowed:

41 minutes

Score:

/34

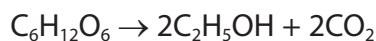
Percentage:

/100

Grade Boundaries:

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

1 Glucose is fermented to produce ethanol.



What is the atom economy, by mass, for the production of ethanol in this reaction?

(Relative molecular masses: $\text{C}_6\text{H}_{12}\text{O}_6 = 180$, $\text{C}_2\text{H}_5\text{OH} = 46$, $\text{CO}_2 = 44$)

- A 25.6%
- B 48.9%
- C 50.0%
- D 51.1%

(Total for Question 1 = 1 mark)

2 The following industrial processes produce ethanol.



(a) What is the atom economy by mass of the fermentation process?

Use the Periodic Table as a source of data.

(1)

- A 25.6%
- B 46.0%
- C 51.1%
- D 92.0%

(b) From a 'green chemistry' perspective, which of the following is an advantage of the hydration of ethene compared to the fermentation process?

(1)

- A The catalyst is less corrosive.
- B A higher temperature is needed.
- C Ethene is a renewable resource.
- D The ethanol is easier to purify.

(Total for Question 2 = 2 marks)

- 3 The relative greenhouse factor of a gas compares the greenhouse effect of a molecule of the gas to that of a molecule of carbon dioxide.

Gas	Percentage by volume in the atmosphere	Relative greenhouse factor per molecule
CO ₂	3.5×10^{-2}	1
CH ₄	1.7×10^{-4}	30
N ₂ O	3.1×10^{-5}	200
CCl ₂ F ₂	4.8×10^{-6}	25 000

Using **only** the data in the table above, select the gas that has the greatest greenhouse effect in the atmosphere.

- A CO₂
- B CH₄
- C N₂O
- D CCl₂F₂

(Total for Question 3 = 1 mark)

- 4 Butane is an aerosol propellant now used as an alternative to CFCs. Although it is less destructive to the ozone layer, it has the disadvantage of being

- A very corrosive.
- B highly flammable.
- C hard to evaporate.
- D highly toxic.

(Total for Question 4 = 1 mark)

5 Which is the **best** explanation of why carbon dioxide, CO_2 , is a greenhouse gas?

- A It is in high concentration and has a long residence time in the upper atmosphere so it absorbs infrared radiation significantly.
- B It is a polar molecule and so absorbs infrared radiation.
- C It absorbs ultra-violet radiation and re-emits infrared radiation.
- D It has polar bonds that absorb and re-emit infrared radiation.

(Total for Question 5 = 1 mark)

6 The term 'carbon footprint' is concerned with the amount of carbon dioxide produced in generating a certain amount of energy.

The table below gives some data about several fuels.

Fuel	Energy density / MJ l^{-1}	CO_2 produced on combustion / g l^{-1}
Petrol	32	2328
Diesel	36	2614
LPG	24	1533
Bioethanol	21	1503

By calculating the mass of CO_2 produced per MJ of energy for each fuel, identify which fuel would give the **smallest** carbon footprint.

- A Petrol
- B Diesel
- C LPG
- D Bioethanol

(Total for Question 6 = 1 mark)

7 Nitrogen oxide, NO, can act as a catalyst in the depletion of the ozone layer. Which of the following reactions is most likely to be a step in the process?

- A $2\text{NO} + 2\text{O}_3 \rightarrow \text{N}_2\text{O}_4 + 4\text{O}$
- B $2\text{NO} + 2\text{O}_3 \rightarrow \text{N}_2 + 4\text{O}_2$
- C $2\text{NO} + 2\text{O}_3 \rightarrow 2\text{NO}_2 + 2\text{O}_2$
- D $2\text{NO} + 2\text{O}_3 \rightarrow \text{N}_2\text{O} + 3\frac{1}{2}\text{O}_2$

(Total for Question 7 = 1 mark)

8 The greenhouse gas with the largest average concentration in the atmosphere is

- A carbon dioxide.
- B methane.
- C nitrogen.
- D water vapour.

(Total for Question 8 = 1 mark)

9 Low molecular mass alkanes are now used as propellants in aerosols. Which environmental problem does this aim to reduce?

- A Acid rain
- B Global warming
- C Non-biodegradability
- D Ozone depletion

(Total for Question 9 = 1 mark)

10 Sustainable chemistry aims to involve processes which use

- A non-renewable resources.
- B a catalyst.
- C high pressure.
- D high temperature.

(Total for Question 10 = 1 mark)

11 There is serious concern over climate change brought about by anthropogenic effects. Which of the following is **not** one of these?

- A Burning of fossil fuels.
- B Deforestation.
- C Intensive agriculture.
- D Volcanic eruptions.

(Total for Question 11 = 1 mark)

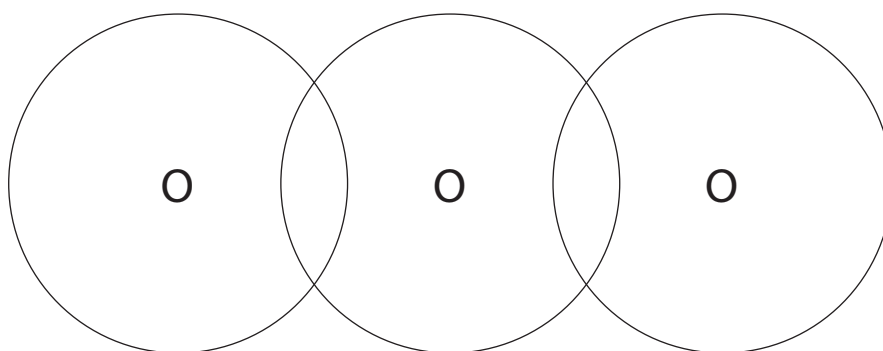
12 This is a question about environmental chemistry.

(a) Ozone, O_3 , is a non-linear molecule present in the Earth's upper atmosphere. It absorbs ultraviolet radiation from the Sun and so protects living organisms from this type of radiation.

(i) Complete the dot and cross diagram for the ozone molecule. Show the outer electrons only.

Use dots (●) for the electrons of the left-hand oxygen atom, crosses (x) for the central oxygen atom and triangles (▲) for the right-hand oxygen atom.

(2)



(ii) Explain why ozone is a non-linear molecule.

(1)

.....

.....

(iii) State **one** harmful consequence to a person of increased exposure to ultraviolet radiation.

(1)

.....

.....

(iv) What property of ultraviolet radiation makes it more harmful than infrared radiation to living organisms? Justify your answer.

(1)

.....

.....

(ii) Suggest a gas, of which there is a significant concentration in the atmosphere, which does **not** absorb infrared radiation.

(1)

(iii) CFCs make a significant contribution to global warming, despite being present in only very small concentrations in the atmosphere. Suggest a reason for this.

(1)

(iv) Suggest why there is now little concern over the contribution of CFCs to global warming compared with that of carbon dioxide.

(1)

(v) Water vapour is another molecule in the atmosphere that absorbs infrared radiation, but it is not considered to be responsible for anthropogenic climate change. Justify this statement.

(2)

(vi) The term 'carbon neutrality' has become widely used with reference to biofuels. Use of biofuels is one of the measures employed in an attempt to stabilise the level of carbon dioxide in the atmosphere and hence to reduce climate change.

Explain the term 'carbon neutrality' and suggest why biofuels are unlikely to be completely carbon neutral.

(2)

(vii) Suggest **two** measures, other than the use of biofuels, by which the chemical industry could reduce its carbon footprint.

(2)

1.....

.....

2.....

.....

(Total for Question 12 = 22 marks)
