The carbon footprint and its reduction

5.9.2.4 · Chemistry · revision notes

What a carbon footprint is, how it can be reduced by cutting emissions of carbon dioxide and methane, and why these actions may be limited. Expect a definition, 'describe actions' and 'give reasons why actions may be limited' questions, and data questions that compare emissions.

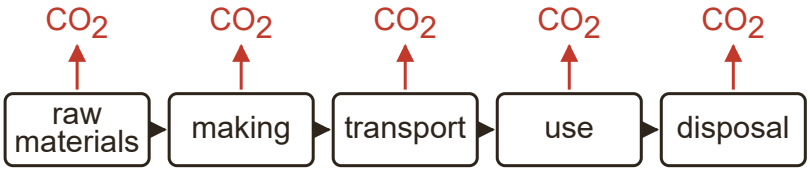
Key facts

- Carbon footprint = total CO_2 and other greenhouse gases emitted over the full life cycle of a product, service or event
- Reduce a footprint by cutting emissions of carbon dioxide and methane
- Carbon neutral = zero net release of carbon dioxide
- 1 kg = 1000 g and 1 tonne = 1000 kg
- Full life cycle: raw materials → manufacture → transport → use → disposal
- Actions: alternative energy, energy conservation, carbon capture and storage, carbon taxes and licences, carbon off-setting (e.g. tree planting), carbon neutrality
- Limits: scientific disagreement, lack of public information and education, lifestyle changes, economic considerations, incomplete international cooperation

Notes

What a carbon footprint is

- The **carbon footprint** is the **total** amount of **carbon dioxide and other greenhouse gases** emitted over the **full life cycle** of a product, service or event.
- Full life cycle means every stage: getting the raw materials, manufacturing, transport, use and disposal.



carbon footprint = total greenhouse gases from every stage

The footprint counts the whole life cycle, not just the use.

- A carbon footprint can be reduced by **reducing emissions of carbon dioxide and methane**.

Actions to reduce emissions

- **Alternative energy supplies**: more use of renewable resources (such as wind, solar and hydroelectric power) and nuclear power instead of fossil fuels.
- **Energy conservation**: using less energy, e.g. insulating buildings, using efficient appliances, and using public transport.
- **Carbon capture and storage**: carbon dioxide from power stations or factories is captured and stored deep underground, e.g. in old oil and gas fields, instead of being released.
- **Carbon taxes and licences**: making companies pay for the greenhouse gases they release, or allowing them to release only a limited amount, encourages them to emit less.
- **Carbon off-setting**: balancing emissions by paying for actions that remove carbon dioxide, such as **planting trees**, which absorb carbon dioxide by photosynthesis.
- **Carbon neutrality**: activities with **zero net release** of carbon dioxide, because any carbon dioxide released is balanced by the same amount removed or offset.
- Reducing methane: collect methane from landfill sites and burn it as a fuel, send less waste to landfill, and farm fewer livestock (e.g. by people eating less meat).

Why actions may be limited

- **Scientific disagreement** over the causes and consequences of global climate change.
- **Lack of public information and education**, so people don't know what to do or why.
- People may not want to make **lifestyle changes**, e.g. flying less or changing their diet.
- **Economic considerations**: many actions are expensive, and some countries depend on fossil fuels for jobs, income and development.
- **Incomplete international cooperation**: not every country agrees to cut emissions, and one country acting alone has a limited effect.

How to answer each type of question

Define carbon footprint 2 marks **Grade 4**

1. Say it is the TOTAL amount of carbon dioxide and other greenhouse gases.
2. Say it is over the FULL LIFE CYCLE of a product, service or event.

Example. What is meant by the carbon footprint of a product?

Model answer. The total amount of carbon dioxide and other greenhouse gases emitted (1) over the full life cycle of the product (1).

Describe actions to reduce emissions

2 to 3 marks | Grade 5

1. Give different actions, not the same idea twice.
2. For each one, say how it reduces emissions (e.g. 'so less fossil fuel is burned').

Example. A school wants to reduce the carbon footprint of its buildings.
Describe **three** actions it could take.

Model answer.

Any three from:

fit solar panels, or buy electricity from renewable sources, so less fossil fuel is burned	(1)
insulate the buildings or use energy-efficient lighting, to conserve energy	(1)
plant trees to offset some of its carbon dioxide emissions	(1)
send less waste to landfill, e.g. by recycling or composting, to reduce methane emissions	(1)

Give reasons why actions may be limited

2 marks | Grade 5

1. Give barriers, not more actions.
2. Choose from: cost (economic considerations), lack of international cooperation, lifestyle changes, lack of public information and education, scientific disagreement.

Example. Many countries have agreed to reduce their greenhouse gas emissions, but global emissions are still high.
Give **two** reasons why.

Model answer.

Any two from:

not all countries cooperate or agree to cut emissions	(1)
reducing emissions is expensive / some countries depend on fossil fuels for their economy	(1)
people are unwilling to change their lifestyles	(1)
there is a lack of public information and education	(1)
there is scientific disagreement about the causes and effects of climate change	(1)

Calculate and compare emissions

2 to 4 marks | **Grade 5**

1. Write down the rate and the amount, e.g. g per km and km.
2. Multiply, then convert units as the question asks (÷ 1000 for g to kg).
3. For a 'net saving', subtract any extra emissions from the amount saved.

Example. A family car emits 150 g of carbon dioxide per km. The family drives 12 000 km per year.
(a) Calculate the mass of carbon dioxide the car emits per year, in kg.
(b) By taking the bus for some journeys, the family would drive 2500 km less per year. Their share of the bus's emissions for these journeys is 50 kg of carbon dioxide per year. Calculate the net saving of carbon dioxide per year, in kg.

Model answer.

(a) 150 × 12 000 = 1 800 000 g (1); ÷ 1000 = 1800 kg (1)

(b) Saving from the car = 150 × 2500 = 375 000 g = 375 kg (1); net saving = 375 − 50 = 325 kg (1)

Evaluate a way of reducing a carbon footprint

3 to 6 marks | **Grade 5**

1. Say how the action reduces greenhouse gases.
2. Give its limitations, e.g. time, cost, whether it really reduces emissions.
3. Use any data given, and finish with a justified judgement.

Example. An airline offers passengers the chance to pay for trees to be planted to offset the carbon dioxide released by their flight.
Evaluate this as a way of reducing the effect of the flight on the atmosphere.

Model answer.

Any three from:

trees absorb carbon dioxide by photosynthesis, so they can balance the carbon dioxide from the flight (1)

but the trees take many years to grow and absorb that much carbon dioxide, whereas the flight releases it straight away (1)

the trees must not be cut down or burned later, or the carbon dioxide is released again (1)

offsetting does not reduce the flight's own emissions; flying less would (1)

Don’t lose marks

- Defining carbon footprint as 'the carbon dioxide from burning fuel'. It includes other greenhouse gases and the whole life cycle.
- Writing 'be more eco-friendly' or 'recycle' without saying how it reduces emissions.
- Thinking that planting trees cancels emissions straight away. Trees take years to absorb the carbon dioxide.
- Saying carbon neutral means 'releases no carbon dioxide'. It means zero NET release.

✕ Giving more actions when the question asks why actions may be limited.

More tips

Memory tricks

- Carbon footprint = 'cradle to grave': count every stage, from raw materials to disposal.
- Six actions: 'All Countries Could Try Offsetting Now': Alternative energy, Conservation, Capture and storage, Taxes and licences, Off-setting, Neutrality.
- Five limits: 'Some People Like Eating Ice cream': Scientific disagreement, Public information lacking, Lifestyle changes, Economic considerations, International cooperation incomplete.
- Unit check: g → kg ÷ 1000, kg → tonnes ÷ 1000.

Exam technique

- A definition of carbon footprint needs three ideas: total, carbon dioxide and other greenhouse gases, full life cycle.
- 'Give reasons why actions may be limited' wants barriers such as cost, cooperation, lifestyle, information and disagreement.
- In 'evaluate' questions, use data from the question, compare the options and finish with a justified judgement.
- Show each step of a calculation with its unit.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Give one way to reduce carbon dioxide emissions**
For example, generate electricity from renewable resources instead of burning fossil fuels.

Grade 4 — **Define carbon footprint**
The total amount of carbon dioxide and other greenhouse gases emitted over the full life cycle of a product, service or event.

Grade 5 — **Describe actions to reduce emissions**
Alternative energy, energy conservation, carbon capture and storage, carbon taxes and licences, carbon off-setting and carbon neutrality.

Grade 5 — **Give reasons why actions may be limited**
Scientific disagreement, lack of public information and education, lifestyle changes, economic considerations and incomplete international cooperation.

Grade 5 — **Describe actions to reduce methane emissions**
For example, collect methane from landfill to use as a fuel, send less waste to landfill, and reduce livestock numbers.

Grade 5 — **Calculate and compare emissions from data**
Use given data, e.g. grams of carbon dioxide per km × distance, and convert units correctly.

Grade 5 — **Evaluate ways to reduce a carbon footprint**
Weigh how much each action saves, its cost and its limitations to reach a justified judgement.

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