Using the Earth's resources and sustainable development

5.10.1.1 · Chemistry · revision notes

How humans use the Earth's natural and finite resources, the difference between finite and renewable resources, and what sustainable development means. On Paper 2 this comes up as short recall questions and as data questions where you interpret information about resources from a table, chart or graph, sometimes using orders of magnitude.

Key facts

- Earth's resources provide warmth, shelter, food and transport
- Renewable resource: replaced as fast as it is used (e.g. timber from replanted forests)
- Natural products can be supplemented or replaced by agricultural and synthetic products
- Order of magnitude = a power of ten; 10^6 to 10^9 is 1000 times bigger
- Finite resource: used faster than it forms, so it will run out (e.g. crude oil, metal ores)
- Sustainable development: meets the needs of current generations without compromising the ability of future generations to meet their own needs
- Years a reserve lasts = reserve ÷ use per year

Notes

Why we use the Earth's resources

- Humans use the Earth's resources to provide **warmth, shelter, food and transport**.
- **Natural resources**, supplemented by **agriculture**, provide food, timber, clothing and fuels.
- **Finite resources** from the Earth, the oceans and the atmosphere (e.g. crude oil, natural gas, metal ores) are processed to provide energy and materials.
- Chemistry improves agricultural and industrial processes, provides new products (e.g. fertilisers, synthetic fibres) and helps with sustainable development.

Finite and renewable resources

- A **finite** resource is not replaced, or forms far more slowly than we use it, so it will run out. Examples: crude oil, coal, natural gas, metal ores.
- A **renewable** resource is replaced at least as fast as we use it. Examples: timber from forests that are replanted, cotton, wool, crops.
- To decide from information, compare the time it takes to form or regrow with how fast it is used: crude oil takes millions of years to form; a cotton crop regrows every year.

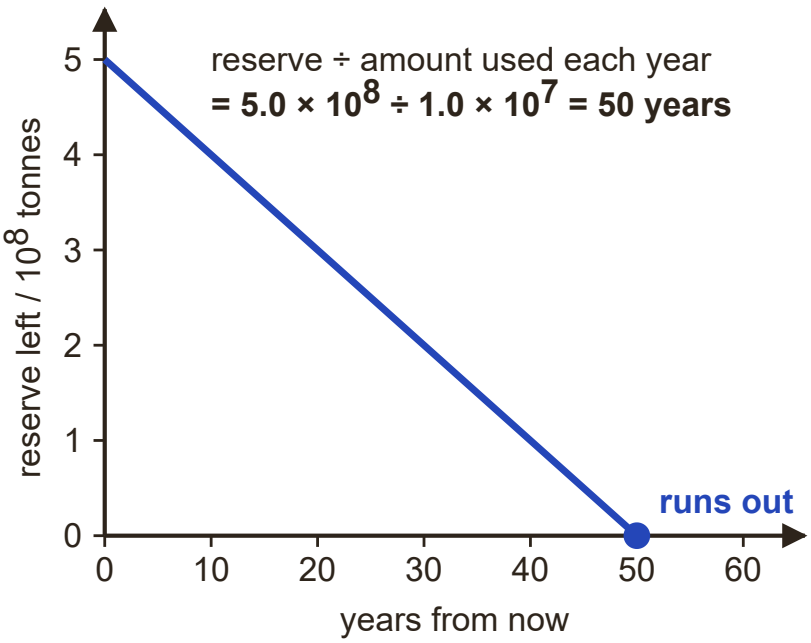
Natural, agricultural and synthetic products

- Many natural products are **supplemented** (added to) or **replaced** by agricultural or synthetic products.
- Examples: wool and cotton by synthetic fibres such as polyester and nylon; natural rubber by synthetic rubber; timber by plastics (e.g. uPVC window frames); wild fish by farmed fish.
- Many synthetic products are made from crude oil, a finite resource, so replacing a natural product is not automatically more sustainable.

Sustainable development and using data

- **Sustainable development** meets the needs of current generations without compromising the ability of future generations to meet their own needs.
- Chemists help by developing processes that use less energy, fewer finite resources and produce less waste (e.g. better catalysts, recycling, renewable raw materials).
- Years a reserve will last = reserve ÷ amount used each year (assuming the rate of use stays the same).

Grade 6+ only



If the rate of use stays the same, the reserve falls in a straight line.

Grade 6+ only

- An **order of magnitude** is a power of ten. 3×10^9 tonnes is about 1000 times (three orders of magnitude) more than 3×10^6 tonnes. Use this to judge whether a difference in data is significant.

How to answer each type of question

Define sustainable development 1 to 2 marks **Grade 5**

1. Give the first part: meeting the needs of people now (current generations).
2. Give the second part: without compromising the ability of future generations to meet their own needs.

Example. What is meant by sustainable development? (2 marks)

Model answer. Development that meets the needs of current generations (1) without compromising the ability of future generations to meet their own needs (1).

Finite or renewable? Give a reason 2 to 4 marks **Grade 5**

1. Use the information: does the resource form or regrow quickly compared with how fast it is used?
2. Name the category: finite or renewable.
3. Give the reason, using the facts or figures in the question.

Example. Natural rubber is collected from rubber trees. New trees can be planted and are ready to use after about 7 years. Synthetic rubber is made from crude oil.
(a) Is natural rubber a finite or a renewable resource? Give a reason. (2 marks)
(b) Explain why replacing natural rubber with synthetic rubber may not be sustainable. (2 marks)

Model answer.

(a) Renewable (1); new trees can be planted and grow in a few years, so it is replaced as fast as it is used (1).
(b) Synthetic rubber is made from crude oil, which is a finite resource (1). Crude oil is being used much faster than it forms, so it will run out and future generations may not be able to meet their needs (1).

Calculate from resource data

2 to 3 marks | Grade 6

1. Pick out the values you need, with their units.
2. Years a reserve lasts = reserve ÷ use per year.
3. Enter standard form with the $\times 10^{x}$ key, or use brackets, so the calculator divides correctly.
4. Give the unit and a sensible number of significant figures.

Example. The known reserves of a metal ore are 6.0×10^{8} tonnes. Each year, 1.5×10^{7} tonnes of the ore are mined.
(a) Calculate how many years the reserves will last if the rate of mining stays the same. (2 marks)
(b) Suggest **one** reason why the reserves may last longer than your answer. (1 mark)

Model answer.

(a) $6.0 \times 10^{8} \div 1.5 \times 10^{7}$ (1) = 40 years (1)
(b) Any one: new reserves may be discovered / more of the metal may be recycled / less of the metal may be needed in future / new methods may allow lower-grade ores to be used (1)

Use orders of magnitude to evaluate data

2 to 3 marks | Grade 8

1. Write each value in standard form.
2. Compare the powers of ten: each power is a factor of 10.
3. Say whether the difference is significant and support this with the numbers.

Example. A country uses 4×10^{7} tonnes of crude oil each year. A new scheme will replace 5×10^{4} tonnes of this crude oil each year with fuel made from crops.
A student says the scheme will make a big difference to the country's use of crude oil. Use orders of magnitude to evaluate the student's statement. (2 marks)

Model answer. The fuel replaces about 10^{4} tonnes compared with about 10^{7} tonnes used, which is three orders of magnitude (about 1000 times) smaller (1). So it replaces only about 0.1% of the crude oil used: the student is wrong, the scheme makes very little difference (1).

Don’t lose marks

- Defining sustainable development as just 'not using up resources'. You need both parts: the needs of current and of future generations.
- Calling timber finite. Timber from forests that are replanted is renewable.
- Assuming a synthetic product is always better for the environment. Many are made from crude oil, a finite resource.
- Typing $6.0 \times 10^{8} \div 1.5 \times 10^{7}$ into a calculator without brackets or the $\times 10^{x}$ key, which gives a wildly wrong answer.
- Saying 'it will run out' without a reason. Say it forms much more slowly than it is used.

More tips

Memory tricks

- Finite = 'finished one day'; renewable = 'renews itself'.
- Sustainable = now AND later: meet today's needs without harming tomorrow's.
- Standard form division: divide the numbers and subtract the powers. $6 \times 10^8 \div 2 \times 10^6 = 3 \times 10^2$.
- One order of magnitude = ×10, two = ×100, three = ×1000.

Exam technique

- When the question says 'use the information' or 'use the table', quote figures from it. General answers score little.
- Always give a reason with 'finite' or 'renewable': the mark is usually for the reason (how fast it forms or is replaced).
- For 'suggest' questions about reserves, any sensible reason that fits the context scores, e.g. new reserves found, more recycling, less demand.

What each grade needs

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

Grade 3 — **State what humans use Earth's resources for**
To provide warmth, shelter, food and transport.

Grade 4 — **Define finite and renewable resources**
A finite resource is used faster than it forms, so it will run out; a renewable resource is replaced as fast as it is used.

Grade 4 — **Give natural products replaced by synthetic ones**
For example, wool and cotton supplemented by synthetic fibres such as polyester, or natural rubber by synthetic rubber.

Grade 5 — **Define sustainable development**
Development that meets the needs of current generations without compromising the ability of future generations to meet their own needs.

Grade 5 — **Classify a resource as finite or renewable**
Use the information given: compare how quickly the resource forms or regrows with how quickly it is used.

Grade 5 — **Interpret resource data from charts and tables**
Read values, describe trends and calculate, for example how many years a reserve will last.

Grade 8 — **Use orders of magnitude to judge data**
Compare powers of ten (10^9 is a thousand times 10^6) to decide whether a difference is significant.

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