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Design & Technology
Eduqas GCSE

Metals: sources, origins, properties and footprint

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try answer all questions
- Use the space provided to answer questions
- Calculators can be used if necessary
- For the multiple choice questions, circle your answer

Advice

- Marks for each question are in brackets
- Read each question fully
- Try to answer every question
- Don’t spend too much time on one question

Good luck!

Q1. Which ore is aluminium extracted from?

A Iron ore

B Bauxite

C Limestone

Q2. Which ferrous metal is steel alloyed with chromium and nickel?

A Stainless steel

B High-speed steel

C Mild steel

Q3. Which property means a metal can be permanently changed in shape without breaking?

A Hardness

B Toughness

C Plasticity

Q4. Which heat treatment reduces the brittleness of hardened steel while keeping some hardness?

A Annealing

B Case hardening

C Tempering

Q5. Compared with extracting it from bauxite, recycling aluminium uses about:

A 95% less energy

B 50% less energy

C 10% less energy

Q6. Which non-ferrous metal can be age hardened to make it much stronger?

A Copper

B Duralumin

C Pewter

Q7. This question is about heat treating metals.

Q7a. A length of brass measuring 120 mm × 20 mm × 5 mm is heated to a dull red colour and left to cool. Name this process. **(1 mark)**

Q7b. Complete the sentence: the process in Q7a makes the brass _____ so that it becomes easier to work. **(1 mark)**

Q7c. A piece of steel is heated to dull red and dipped into carbon powder. This is repeated three times. The steel is then reheated to dull red and quenched in water. Name this process. **(1 mark)**

Q8. This question is about steels.

Q8a. The cutting blade of a garden tool is made from carbon steel. Explain why carbon steel is an appropriate material for the cutting blade. **(2 marks)**

Q8b. The chains that attach the mast to a wooden ship in a children's playground are made from stainless steel. Give two reasons for using stainless steel for the chains. **(2 marks)**

Q9. A set of cutlery is manufactured from stainless steel.

Q9a. Explain one working property of stainless steel that makes it suitable for the cutlery. **(3 marks)**

Q9b. Explain two negative effects on the environment of producing stainless steel. **(4 marks)**

Q10. A desk lamp is made from mild steel. The iron ore for the mild steel is sourced from Russia. Explain two effects on the landscape of extracting iron ore for the mild steel. **(4 marks)**

Q11. Aluminium drinks cans can be crushed at home using a simple lever, ready for recycling. Analyse the environmental benefits of consumers crushing and recycling aluminium cans. **(3 marks)**

Q12. Parts of a children's construction kit are made from aluminium. Explain two reasons why aluminium could be considered a sustainable material. **(4 marks)**

Q13. Raw aluminium comes from mining an ore, which is then processed into the material used to manufacture a child's toy. Analyse the impact mining aluminium has on our ecological footprint. **(5 marks)**

Q14. Over two billion aluminium fizzy drinks cans are manufactured every year. Undertake a life cycle analysis of a fizzy drinks can, explaining the impact it has on the environment. **(5 marks)**

Answers

Q1. B
Q2. A
Q3. C
Q4. C
Q5. A
Q6. B

Q7a.

Annealing (1).

Q7b.

Any one (1): softer; more pliable; more malleable; less brittle.

Q7c.

Case hardening (1).

Q8a.

1 mark for a simple response, e.g. carbon steel is harder than other options, or it keeps the blade sharper for longer.

2 marks for a more detailed explanation, e.g. carbon steel is stronger and harder, which means it will stay sharper for longer and need less maintenance than, for example, stainless steel. Or: carbon steel costs less than stainless steel, so even though it performs better, the tool will also cost less to manufacture.

Q8b.

Any two (1 mark each). Answers must relate to the chains on playground equipment; do not accept one word answers such as "strong" without a reason:

- Resistant to wear, hard wearing, durable
- Resistant to corrosion
- Resistant to heat and fire
- Low maintenance, easy to clean

- Impact resistant, high tensile strength
- Aesthetically pleasing

Q9a.

A working property (1) plus two linked justifications (1) + (1). For example:

- It is corrosion resistant or non-toxic (1), so it will not rust or degrade in contact with water (1), so the cutlery stays hygienic and lasts longer (1)
- It can be forged, cast, rolled or stamped (1), so each piece of cutlery can be made in one piece (1), so no joints, welds or fixings are needed (1)
- It is unaffected by changes in temperature (1), so it can be cleaned at high temperatures (1) without losing its strength or deforming (1)
- It has good toughness and hardness (1), so the prongs keep their shape (1) while also being slender (1)

Q9b.

Two negative effects (1 mark each), each with a linked justification (1 mark each). For example:

- Producing steel uses a lot of energy (1), which creates a lot of pollution and contributes to climate change (1)
- Extra elements such as chromium have to be sourced (1), which uses up finite resources (1)
- Iron ore has to be mined (1), which damages the environment and the landscape (1)

Q10.

Two effects of extracting iron ore (1 mark each), each with a linked justification (1 mark each). For example:

- Land is stripped bare of all plant life (1), causing loss of soil fertility, large exposed areas, and a higher risk of flooding or landslides (1)
- Large areas and forests are destroyed by open cast mining (1), so local people lose living space and animals and species are lost (1)
- Extraction creates a large amount of waste material (1), leaving unsightly spoil heaps near the mines (1)
- Pollutants can enter waterways (1), so chemicals leach into the ground and wildlife is lost (1)

- Large areas of ground can become unstable (1), so the land cannot be used for anything else, sink holes can form, or ground water is affected (1)

Q11.

Answers must relate to metal (aluminium) cans and/or recycling. 1 mark for each benefit (maximum of 2 marks for just stating two benefits), 1 mark for analysing the benefit and 1 mark for justifying it. Two benefits with a sound explanation can also get 3 marks. Benefits could include:

- Crushing cans makes the most of recycling space in the home
- Aluminium can be recycled without affecting the strength of the metal
- Aluminium can be recycled into a range of different products
- Cans are collected by refuse collectors (no need to visit a recycling centre), so less ends up in landfill
- Recycling cans creates jobs and community services
- Recycling avoids the need to mine new resources

Q12.

Two reasons (1 mark each), each with a linked justification (1 mark each). For example:

- Recycled aluminium is readily available (1), so less raw material or ore needs to be extracted from the ground (1)
- Recycling aluminium uses less energy than other metals (1), so the overall impact on the environment is reduced (1)
- Aluminium is lightweight (1), so less energy is used and fewer emissions are created during transport (1)
- Aluminium is easily recycled at the end of its useful life (1), so once thrown away the parts can easily be sorted and recycled (1)

Q13. (5 marks)

Indicative content (not all needed):

Negative impacts

- It takes a lot of energy to quarry the bauxite rock that aluminium comes from

- The bauxite has to be transported from the quarry to where the aluminium is extracted
- Even more energy is needed to extract the aluminium from the bauxite by electrolysis
- The aluminium then has to be made into bars, sections, tubes or sheets, which uses more energy
- The aluminium is then transported to make products; global transport increases the carbon footprint

Positive impacts

- Aluminium is 100% recyclable and can be reused to make other products (credit recycling only if it is linked to reducing the mining of raw materials)
- Money can be saved if the material is recycled rather than taken from its natural source
- Factories can be located at or near the source of the aluminium to avoid unnecessary transport

Band	Marks	Descriptor
3	4 to 5	A coherent answer with detailed, relevant knowledge and understanding of the ecological footprint of quarrying bauxite and extracting the aluminium by electrolysis. Relevant examples and a well-developed, logical chain of reasoning, sustained throughout.
2	2 to 3	Some coherence, with partial knowledge and understanding of the ecological footprint of quarrying and extracting aluminium. Mostly relevant examples and a logical chain of reasoning that may not be sustained throughout.
1	1	Basic knowledge and understanding. Limited relevant examples or logical chain of reasoning.
0	0	Incorrect or irrelevant answers.

Q14. (5 marks)

A life cycle analysis looks at the environmental impact of a product from the extraction of its raw materials to its use and disposal. Indicative content (not all needed):

- Aluminium ore has to be mined and the aluminium extracted from it, which takes a lot of energy, and transport costs are high
- At every stage, the energy used to transport the parts (by lorry, ship or aircraft) has a large environmental impact and should be mentioned

- Manufacturing takes place in different locations; the raw materials and empty cans are shipped on to be filled and to have the tops fitted
- Empty cans are lighter to transport, so they are sent to drinks manufacturers before filling; global manufacturers fill cans in various locations to save transport
- Filled cans are packaged and distributed to shops
- Aluminium cans are recycled to reduce the cost of raw materials and to keep the raw materials needed for future production

Band	Marks	Descriptor
3	4 to 5	A coherent answer with detailed, relevant knowledge and understanding of the environmental impact of the can on our planet. Relevant examples and a well-developed, logical chain of reasoning, sustained throughout.
2	2 to 3	Some coherence, with partial knowledge and understanding of the environmental impact. Mostly relevant examples and a logical chain of reasoning that may not be sustained throughout.
1	1	Basic knowledge and understanding. Limited relevant examples or logical chain of reasoning.
0	0	Incorrect or irrelevant answers.