

Design & Technology

Edexcel GCSE

Modern Materials

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. Identify the correct definition of a modern material.

- A** A combination of two or more different materials
- B** A material produced through a new or improved production technique
- C** A material that changes its properties when exposed to heat

Q2. Which element is graphene made from?

- A** Carbon
- B** Aluminium
- C** Titanium

Q3. Which property makes metal foams suitable for car crash structures?

- A** They absorb impact energy as they crush
- B** They are very heavy
- C** They are transparent

Q4. Why is titanium used for hip replacements?

- A** It is the cheapest metal available
- B** It is biocompatible and corrosion resistant
- C** It is magnetic

Q5. Which one of the following is a composite material?

- A** Graphene
- B** Titanium
- C** Carbon fibre reinforced plastic (CRP)

Q6. How thick is a single sheet of graphene?

- A** One atom thick
- B** One millimetre thick
- C** One centimetre thick

Q7. Modern materials are used to improve many products.

Q7a. Name one specific modern material. **(1 mark)**

Q7b. Explain why the use of modern materials improves the function of products. **(2 marks)**

Q8. A bicycle has a frame manufactured from titanium.

Q8a. Explain one benefit of manufacturing the bicycle frame from titanium. **(2 marks)**

Q8b. Explain one cost factor that will have been considered when selecting titanium as the material from which to manufacture the bicycle frame. **(3 marks)**

Q9. A toolbox has aluminium compartments that are opened and closed using titanium linkages.

Explain one issue associated with the ecological footprint of using titanium for the toolbox linkages. **(3 marks)**

Answers

Q1. B

Q2. A

Q3. A

Q4. B

Q5. C

Q6. A

Q7a.

One mark for a correct specific modern material. Specific smart materials are also accepted. Accept: carbon fibre, corn starch polymers, D3O, flexible MDF, Gore-Tex, graphene, Kevlar, liquid crystal displays (LCDs), metal foams, nanomaterials, titanium, nitinol/SMA, thermochromic or photochromic pigments, QTC, polymorph. Do not accept memory foam (generic), nylon or plywood.

Q7b.

2 marks for two correct simple points of explanation, or one point explained in detail (possibly using a specific example); 1 mark for one correct simple point. Do not accept unqualified generic answers such as "strong" or "cheap".

Indicative content:

- A range of materials specifically developed to meet specific product requirements, e.g. Pyrex for heat resistance (2)
- Improved materials with enhanced properties not available in traditional materials, e.g. wood, metal (2)
- Improved durability of products in working conditions, e.g. heat, stress (2)
- Longer lasting products (1)

Accept all other valid responses.

Q8a.

Any one explanation that includes a benefit of using titanium (1 mark) and a linked justification of that benefit (1 mark):

- Titanium has a high strength to weight ratio (1), which means thinner/smaller tubes can be used, making the bike lighter (1)

- Titanium is tough/impact resistant/able to flex in use (1), which means the bicycle will be more comfortable to ride/can absorb bumps from uneven surfaces (1)
- Titanium has high levels of corrosion resistance/does not rust (1), which means the frame would not need to be painted/have a finish applied (1)

Q8b.

Any one explanation of a cost factor (1 mark), plus linked justifications (1 mark + 1 mark):

- The quality/grade of the titanium ore will affect the cost of the material (1), which means lower grades will be cheaper (1), which may result in a bicycle frame that lacks strength (1)
- The availability/location of ore containing titanium will be a factor (1), which means prices may vary (1), resulting in a higher cost (1)
- Levels of supply/demand for titanium will vary (1) due to its other uses in the automotive/chemical/aerospace industries (1), resulting in higher cost prices (1)

Q9.

Any one explanation of an issue associated with the ecological footprint of using titanium (1 mark) plus two linked justifications (1 mark + 1 mark):

- Titanium ore is extracted using mining/open cast mining (1), which destroys local landscapes/countryside/causes deforestation (1), meaning animal habitats are destroyed (1)
- The extraction of titanium from ore uses chlorine gas (1), which results in the emission of greenhouse gases (1), contributing to climate change (1)
- The production of titanium uses large amounts of water (1), which results in impurities/contamination entering the water (1), affecting local people/wildlife (1)
- The production of titanium involves high-temperature reactions (1), so a large amount of energy is required (1), which contributes to greenhouse gas emissions (1)