

Design & Technology

Edexcel GCSE

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

- A** Carbon fibre reinforced plastic (CRP)
- B** Graphene
- C** High impact polystyrene (HIPS)

Q2. Identify the correct definition of a composite material.

- A** A material that changes its properties in response to a stimulus
- B** A material that occurs naturally
- C** Two or more different materials combined to make a material with better properties

Q3. Concrete is very strong when it is

- A** pulled (in tension)
- B** squashed (in compression)
- C** twisted (in torsion)

Q4. Why are the layers of plywood glued with the grain of each layer at 90° to the next?

- A** To make it strong in all directions and resist warping
- B** To make it look more attractive
- C** To make it cheaper to manufacture

Q5. What is added inside reinforced concrete to increase its tensile strength?

- A** Glass fibre
- B** Steel bars
- C** Wood veneers

Q6. Which of the following is an environmental disadvantage of most composite materials?

- A** They are very heavy
- B** They rust easily
- C** They are difficult to recycle because the materials are hard to separate

Q7. A sports rowing boat is manufactured from fibreglass, which is a composite material.

Q7a. Name one composite material other than fibreglass. **(1 mark)**

Q7b. Explain one reason for manufacturing the sports rowing boat from fibreglass. **(2 marks)**

When manufacturing fibreglass, the glass fibre matting is coated with a mixture of resin and a catalyst. The resin and catalyst are mixed in the ratio of 100 g resin to 2 ml of catalyst.

Q7c. Calculate how much catalyst would be added to 650 g of resin. **(2 marks)**

Q8. The manufacturer of an electrically powered hand drill is considering using carbon fibre for the main body.

Explain two benefits of using carbon fibre for the main body of the electrically powered hand drill. **(4 marks)**

1

2

Q9. A manufacturer is developing a new games controller that uses robotic materials.

Explain one way that robotic materials can be used in the new games controller. **(2 marks)**

Q10. Composites combine the properties of two or more materials.

Q10a. GRP is an example of a composite material. State the meaning of GRP. **(1 mark)**

Q10b. Explain why designers might avoid using composite materials for modern sports equipment. **(3 marks)**

Answers

Q1. A

Q2. C

Q3. B

Q4. A

Q5. B

Q6. C

Q7a.

Any one from (1 mark): carbon fibre, concrete, plywood, MDF, chipboard, robotic materials, reinforced polymers/textiles. Do not accept GRP/fibreglass/glass fibre.

Q7b.

Any one reason for using fibreglass (1 mark) and a linked reason for the use (1 mark):

- Fibreglass is a tough material (1), which means it can withstand the knocks and bumps of hitting rocks/stones (1)
- Fibreglass is water resistant (1), which means it will not absorb water when out on the river (1)
- Fibreglass can be moulded into complex shapes (1), which means it can create curved shapes/smooth lines/a streamlined single-piece moulding (1)
- A high-quality surface finish can be achieved from the mould (1), which reduces friction/allows the boat to move better through the water (1)
- Fibreglass forms a lightweight structure (1), which means it will be easy to lift the boat out of the water (1)
- Low maintenance material (1), which means it does not need to be re-varnished/repainted (1)
- Resin can be pigmented (1), which means no painting/colouring is needed after moulding (1)

Q7c.

A calculation that includes (award full marks for the correct answer without working):

- Correct working out: $100/2 = 650/x$, or $(2 \times 650) \div 100$ (1)

- Correct answer: 13 ml (1)
- Alternative method: $6 \times 2 = 12$ ml, plus $0.5 \times 2 = 1$ ml; $12 + 1 = 13$ ml

Q8.

Any two benefits of using carbon fibre for the main body (1 mark each) and a linked justification of each benefit (1 mark each). Do not accept durable, hard wearing or tough.

- It is lightweight (1), which means it is not too heavy for the user to hold/they can work longer without tiring (1)
- It can be formed into complex shapes/forms (1), which means smooth/sleek/ergonomic forms can be manufactured (1)
- It has an excellent strength to weight ratio (1), which means although it is light, it is capable of normal/intended use (1)

Q9.

Any one explanation that references the use of robotic materials (1 mark) and a linked justification of that use (1 mark):

- They can be used to sense movement of the hand (1), and so can act as steering/directional controllers (1)
- They can sense pressure/being squeezed (1), therefore eliminating the need for additional buttons (1)
- They can be used to communicate with users (1), which means sensations can be sent back to the hands as vibrations/pulses (1)
- Robotic materials can be used for computational purposes within the material (1), therefore reducing the number of internal components (1)

Q10a.

Glass reinforced plastic (1 mark). Accept glass reinforced polymer/polyester.

Q10b.

Up to 3 marks for a clear explanation; maximum 1 mark for simply listing reasons. For example: composite materials are time-consuming to manufacture (1); cutting and shaping composites after forming is difficult due to their strength (1), making them expensive for consumers (1). Or: composites are made from two materials that are difficult to separate and recycle once

combined (1), so they are not environmental choices (1) and often end up in landfill (1). Other disadvantages:

- High production costs; specialist equipment and high-quality moulds needed
- Fragile compared to metals/modest impact resistance
- Difficult and/or expensive to repair
- Curing composite materials can take up to 10 hours
- Many composites are vulnerable at high temperatures and can release toxic particles and fumes, which are a health risk
- May give an unfair advantage in competitive sport

Credit any other appropriate response.