

## **OCR A-Level**

# **Reinforcing and Stiffening Materials for Structural Integrity (6.1a)**

### **Materials required for questions**

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- Pencil
- Rubber
- Calculator

### **Instructions**

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- 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**

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- 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.** Why might a thin sheet of metal be reinforced with ribs or folds?

- A** To improve its conductivity
- B** To increase its resistance to bending
- C** To reduce its overall density

**Q2.** Which of the following is an example of reinforcing a material?

- A** Adding glass fibres to a polymer
- B** Painting a metal surface
- C** Polishing an acrylic sheet

**Q3.** A bridge truss is reinforced with triangular gusset plates at joints. What is the primary effect of these reinforcements?

- A** They redirect tensile forces into compressive loads
- B** They distribute stresses more evenly across the join
- C** They increase torsional flexibility to absorb shock

**Q4.** When using carbon fibre reinforced polymer (CFRP) in aerospace structures, the orientation of fibres is carefully controlled. Why?

- A** To optimise load paths and resist directional stresses
- B** To improve electrical conductivity in all directions
- C** To reduce the weight of the matrix material

**Q5.** The image shows a swing seat manufactured from hardwood. The swing seat has three main parts which include the seat, the frame and the chains. The chains allow the seat to hang and swing.



Describe two features of the frame of the swing seat that improve its structural integrity. **(4 marks)**

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**Q6a.** Describe what forces are acting on the bow and arrow in the image before it is fired. **(3 marks)**



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**Q6b.** Explain how materials can be improved by being reinforced. Give examples. **(3 marks)**

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## Answers

**Q1.** B

**Q2.** A

**Q3.** B

**Q4.** A

**Q5.**

Possible responses may include:

- The triangular legs (1) which increase stability and prevent toppling (1).
- The additional bracing at the top (1) which strengthens the frame and prevents twisting (1).
- Any other suitable suggestion.

**Q6a.**

- Bending
  - Compression
  - Tension
  - Torsion
  - Shear
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- When the bow string is pulled back it is under tension.
  - The bow is stressed with a bending force (or an element of bending ie tension /compression)
  - The arrow is under compression until the archer releases their grip.
  - The bow is under dynamic load/force when any parts are moving.
  - The bow is under compression from the archer's hand.
  - The string is in tension

**Q6b.**

The guidance provided is illustrative and not exhaustive. Credit any worthy points made in support of the band descriptors above.

Concrete

- Reinforced with steel bars/rods to improve resistance to tensile forces in modern architecture.

### Fabrics

- Use of polymers/Vilene in shirt collars to prevent bending, creasing and stop collar from curling.
- Retain 'sharp' point on collar.
- Rivets in jeans
- French seam
- Flat felled seam
- Hems
- Overlocking
- Interfacing to reinforce/stabilise/stiffen fabric.

### Lamination

- Layer of timber (lamins) used in glulam construction to create longer wood beams for architecture better able to resist bending forces.
- Lamination of paper and card using a polymer wallet. This improves tear resistance and resistance to moisture preventing wood fibres from disintegrating.

### Composite materials

- CRFP (Carbon reinforced polymer). Two or more dissimilar materials are joined together to create a material that is better than its constituent materials, ie best properties of both.

### Ribbing/webbing/fillets/gussets

- Ribbing and webbing are used extensively in the manufacture of polymer products to reduce the quantity of material used and weight. These reinforcements increase stiffness eg polymer food packaging eg bakery, fruit
- Fillets are Intentional rounding of an internal corner to reinforce and provide additional structural support.
- Gusset/flitch plates used in engineering and textiles are a triangular shaped inset on a structural joint or seam.

Accept other valid responses.