DTBase©

Design & Technology
Eduqas GCSE

Metals: forces, stresses, reinforcing and stiffening

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 force pulls materials apart, e.g. in the steel cables of a suspension bridge?

A Tension

B Compression

C Shear

Q2. Which force is a twisting force, e.g. in the drive shaft of a vehicle?

A Bending

B Shear

C Torsion

Q3. Bending is a combination of which two forces?

A Shear and torsion

B Tension and compression

C Compression and torsion

Q4. Which stock form is stiffer than a solid rod of the same weight?

A Flat bar

B Tube

C Square rod

Q5. How can thin sheet metal be made much stiffer?

A Folding or ribbing it, e.g. a flange or corrugation

B Annealing it

C Polishing it

Q6. A spring is made from medium carbon steel so it can flex repeatedly without breaking. How is it heat treated?

A Annealed, then work hardened

B Case hardened

C Hardened, then tempered

Q7. A table lamp is cut from a single piece of brass. Its two side pieces are bent outwards into curves, and a small top part fits between the tops of the two side pieces to hold them in shape. State the type of force the top part is subjected to from the two side pieces. **(1 mark)**

Q8. A mobile crane has extended legs at its base, a vertical tower that turns, a jib, and steel cables that lift the load. Components of the crane will be affected by compression, tension and torsion. Give one example of where each of these forces occurs when the crane is operating. **(3 marks)**

Q9. A solar powered garden light is held off the ground by a stainless steel support that is pushed into the ground. Explain one reason for using stainless steel for the support. **(2 marks)**

Q10. A tool hook for a workshop is made from mild steel bent into a curve. Part of it is dip coated. Give two different properties of mild steel that make it an appropriate choice of material for the tool hook. For each property, explain one advantage of using mild steel for the tool hook. **(6 marks)**

Q11. This question is about the structure of metal products.

Q11a. A children's scooter has a frame, stand and handlebars fabricated from aluminium alloy, and a textured aluminium alloy deck. Explain two aspects of the design of the scooter that ensure it has good structural integrity. **(2 marks)**

Q11b. A shopping trolley has a basket and frame made from low carbon steel rod and tube that has been cut, formed and welded. Explain how the form or structure of the shopping trolley helps it achieve its function. **(2 marks)**

Q12. Metals can have their properties modified for specific purposes. Explain how and why a metal can be modified. Give an example in your answer. **(3 marks)**

Q13. An interior wall lamp has a curved bracket made from 15 mm diameter brass tube. Explain two working properties of brass that make it an appropriate choice of material for the curved bracket. **(6 marks)**

Answers

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

Q7.

Compression or compressive (1).

Q8.

One example for each force (1 mark each). For example:

- Compression: in the vertical parts of the crane structure, from the load being lifted and the weight of the crane itself; or in the extended legs (allow the wheels or tyres)
- Tension: in the cables carrying out the lift
- Torsion: in the tower when the crane turns while carrying a load; or in the jib when the wind blows on it

Q9.

A reason (1) and a linked justification (1). For example:

- Stainless steel is hard and has good compressive strength (1), so it can be pushed into the ground without bending or deforming (1)
- Stainless steel resists corrosion (1), so it will not rust in the wet, damp ground and keeps its appearance (1)
- Stainless steel is tough (1), so it can be knocked into the ground with a hammer or withstand knocks from a lawnmower (1)

Q10.

For each of two properties: the property (1) plus two linked justifications (1) + (1). For example:

- It is tough (1), so it can withstand knocks and bumps (1), so it will have a long service life (1)

- It is ductile or malleable (1), so it will not fracture when it is stretched or bent to shape (1), so it can be formed into a curve (1)
- It has good tensile strength (1), so the hook will not stretch or deform in use (1), so it can support heavy tools (1)
- It can withstand relatively high temperatures (1), so it will not deform when heated (1), so it can be dip coated (1)

Q11a.

Any two (1 mark each). Do not accept properties, or repeats of the information given, unless the answer says how it improves the structural integrity:

- Tubular sections add strength
- Welding the frame gives solid joints
- A frame structure with members joined together
- The textured material on the foot plate (deck) adds reinforcement

Q11b.

Identify a form or structure (1) and explain how it helps the trolley function (1). For example:

- A lattice frame structure (1); the over and under rods give it strength (1)
- The overall shell shape uses some triangulation, as the base is smaller (1), with bent pieces reinforcing the edges of the frame (1)

Q12.

Marks	Descriptor
3	A detailed description of how a metal can be modified, with an example.
2	A simple description and an example, or a detailed description with no example.
1	A valid simple point or a named modification.
0	Nothing worthy of credit.

Answers about surface finishes rather than a modification of the material get a maximum of 2 marks. Indicative content:

- Annealing: softening the metal by heating it to a set temperature, to make it more ductile and easier to work

- Hardening: making the surface of the metal more resistant to wear, e.g. case hardening gears
- Tempering: reducing the stresses in hardened metal so it is less brittle, e.g. garden tools

Q13.

For each of two working properties: the property (1) plus two linked justifications (1) + (1). For example:

- Brass is malleable (1), so it can be cold worked or formed (1), so the curve can be made without heat treatment, tearing or fracturing (1)
- Brass does not corrode (1), so it will not degrade over time (1), as a protective coating forms on the surface (1)
- Brass is hard (1), so it will not easily be damaged by knocks (1), so the bracket is unlikely to fail over time (1)
- Brass is ductile (1), so it can be drawn (1), allowing tubes to be formed (1)