

Design & Technology

Heat Treatments

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try to 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
- Don't spend too much time on one question

Good luck!

Q1. What is the name of the process used to control the brittleness caused as a result of hardening?

- A** Annealing
- B** Case Hardening
- C** Tempering

Q2. Which one of the following best describes the process of case hardening?

- A** Makes the outside surface harder
- B** Increases the hardness of the entire piece of metal
- C** Removes the brittleness of the metal once hardened

Q3. Complete the statement by adding the correct material from the list below 'Hardening and tempering is a process that is carried out on...'

- A** Thermosetting plastic
- B** Composite material
- C** Carbon steel

Q4. Which of the following statements is true?

- A** Tempering a metal hardens the outer surface only
- B** Hardening a metal removes brittleness
- C** Annealing a metal makes it easier to shape

Q5. Which one of the following statements about normalising is false

- A** Relieves internal stress on metal
- B** Increase in hardness
- C** Can't normalise non-ferrous metals

Q6. Which method requires rapid cooling of the metal via quenching?

- A** Annealing
- B** Hardening
- C** Normalising

Q7. Why might you normalise a metal?

- A** To allow the metal to be easier to machine
- B** To make the metal less brittle
- C** To increase hardness of metal on outside

Q8. A set of pliers have been hardened as part of the manufacturing process. Use notes and/or sketches to explain/describe the process of hardening and tempering **(4 marks)**

Q9. Discuss the reasons why the copper used to make a bowl will be annealed before being formed into its finished shape **(3 marks)**

Q10. Cheaper knife blades can be made from carbon steel.

The carbon steel has been hardened. Describe the process of hardening the knife blade **(2 marks)**

Q11. A mild steel spanner needs to be hardened in order to prolong its durability.

Describe how the spanner could be hardened in a school workshop **(3 marks)**

Q12. A chisel blade is manufactured from carbon steel. During manufacture the chisel blade becomes work hardened. Name two heat treatment processes that are used to restore the metal's mechanical properties making it tougher and less brittle. **(2 marks)**

1.

2.

Answers

Q1. C

Q2. A

Q3. C

Q4. C

Q5. B

Q6. B

Q7. A

Q8.

Up to 2 marks for the notes (1 mark for basic notes)

Up to 3 marks for the sketch(es) (1 mark for basic sketch)

- Steel is heated to red heat (1)
- It may only be necessary to harden one part of steel so heat is concentrated in this area (1)
- Steel is removed from the brazing hearth with blacksmiths tongs into case hardening compound and allowed to cool a little (1)
- The case hardening compound is high in carbon (1)
- Steel is heated again to red colour and plunged into cold clean water (1)
- Steel rod should now have a hardened outer surface and flexible soft interior (1)
- Process can be repeated to increase the depth of the hardened surface (1)

Q9.

- Appropriate discussion point but lacking detail award 1 mark, e.g. to soften the copper (1)
- Appropriate discussion, includes some detail award 2 marks, e.g. the copper will become harder as it is being worked with so it will need to be softened (1)
- Appropriate discussion, well detailed award 3 marks, e.g. the copper will become harder as it is being worked with so it will need to be softened as it can become brittle and break when bent or hammered

Answers related to:

- Relieve internal stresses in the copper
- To make it easier to work with/easier to shape/form
- To prevent cracks forming

- Work hardening

Q10.

- The blade is **heated** red/cherry/red hot/critical temperature/900 degrees Celsius and then **quenched/dipped** in water (1)
- Blade is heated and dipped into carbon powder, allowed to cool, process repeated several times (1)

Q11.

- Heating steel to red hot.
- Dipping in carbon powder.
- Allowing time for carbon to soak into steel.
- Repeating above 2 or 3 times.
- Re-heating to red hot.
- Quenching in water.

1 mark – basic understanding (reference to 1 or 2 of the points above)

2 marks – more detail (reference to 3 or 4 of the points above)

3 marks – detailed response (reference to 5 or 6 of the points above)

Q12.

- Annealing (1)
- Normalising (1)
- Tempering (1)