

## 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 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**      A dovetail joint is a knock down joint
- B**      Steel is a common non-ferrous metal
- 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)**

---

---

---

---

---

---

## **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)