**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** Tempering

**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)