**2****32**

**Heat Treatment and Work Hardening of Metals**

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**Acknowledgement**

Mr John Gibson is a highly regarded educator and engineer. John taught Industrial Arts at a number of high schools before taking a position at Sydney Teachers’ College, then University of Sydney. He had an engineering education consultancy and has extensive experiencing working with NESA on Engineering Studies syllabus development and the HSC examination committee. The STEM Industry School Partnerships (SISP) Program asked John for his responses to the iTeachSTEM topic discussion questions. SISP is grateful to John for submitting these example discussion responses.

# What are the processes that might increase the hardness of metals?

* alloying
* cold working
* work hardening
* heat treatment

1. **What are the processes that might soften many metals?**

* alloying
* annealing

1. **Describe strain hardening/work hardening/cold working, including what occurs when metals are deformed during cold rolling, compressing or, elongation.**

* In cold working operations, grains are initially distorted elastically. The process continues and atoms, being loosely associated to the electron cloud, are distorted permanently, **slip** and **dislocation**. Distorted slip planes require greater force to further work the metal.

1. **Describe the annealing process of an 0.8% Carbon cold rolled steel and the effect on structure and properties of the steel.**

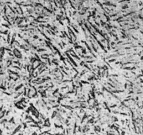
* annealing: heat to 750°C, soak, allow to cool
* structure: grains of equiaxial Austenite undergo the eutectoid reaction to form Pearlite (a mixture of Ferrite and Cementite)
* properties: reduction in strength, increase in elongation, harder

# Steel

1. **Describe both hardening of high carbon steel and the tempering of the hardened steel.**

* Hardening 1.4% C: heat just above the eutectoid temperature, soak, quench in water
* Tempering 1.4% C: heat to chosen temperature between 100°C and 600°C to gain desired structure, quench in water

1. **Draw the microstructure of a 0.8% C hardened steel.**



*Structure of Martensite Crystals*