4.3 Metals and alloys

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS phase diagram • eutectoid • lever rule

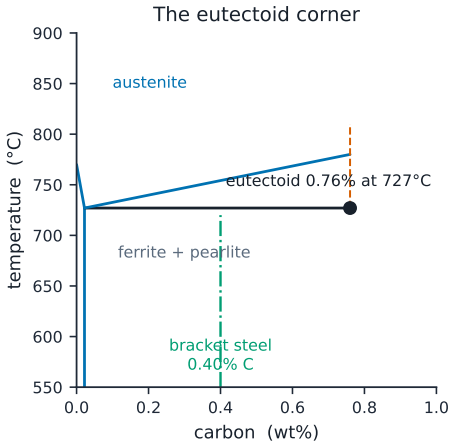
Objective

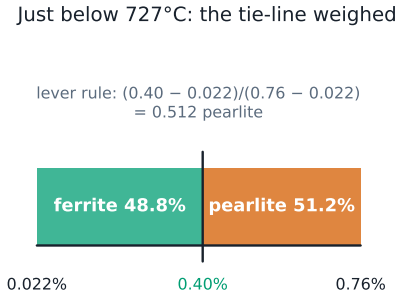
Read the iron-carbon map and weigh phases with the lever rule; compute strain-hardened strengths and name the quench products.

1 Key knowledge and worked examples

■ The map and the rule

Eutectoid 0.76 wt% C at 727°C; ferrite limit 0.022%. Just below: pearlite fraction $(C_0 - 0.022)/(0.76 - 0.022)$. Strain hardening: $\sigma = K\varepsilon^n$.





*Read the phases; weigh them

■ Worked example. The bracket steel

0.40%: pearlite = 0.378/0.738 = 0.512, ferrite 0.488 ✓; with $K = 530$, $n = 0.20$: 401.7 MPa true at 25% work ✓.

2 Practice

2.1 For a 0.60 wt% C steel just below 727°C: the pearlite and ferrite fractions (four decimals). [4]

2.2 A copper alloy has $K = 600$ MPa and $n = 0.25$: the true stress at a true strain of 0.16 (one decimal). [3]

2.3 State the phases and their carbon contents at the eutectoid point, and name the product of a fast quench from the austenite field. [4]

2.4 One sentence each: why can the same grade ship at two yield strengths, and why is martensite tempered before service? [3]

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Solutions

2.1

- Pearlite $= (0.60 - 0.022)/(0.76 - 0.022) = 0.7832$.
- Ferrite $= 1 - 0.7832 = 0.2168$.

2.2

- $\sigma = 600 \times 0.16^{0.25} = 379.5$ MPa.

2.3

- Austenite (0.76% C) decomposes to ferrite (0.022%) + cementite (6.67%) as lamellar pearlite at 727°C.
- A fast quench gives martensite.

2.4

- The processing state - cold work or heat treatment - sets the properties; the grade only fixes the chemistry.
- Untempered martensite is hard but brittle; tempering restores toughness at some strength cost.

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