Recitation

Iron – Carbon Phase Diagram

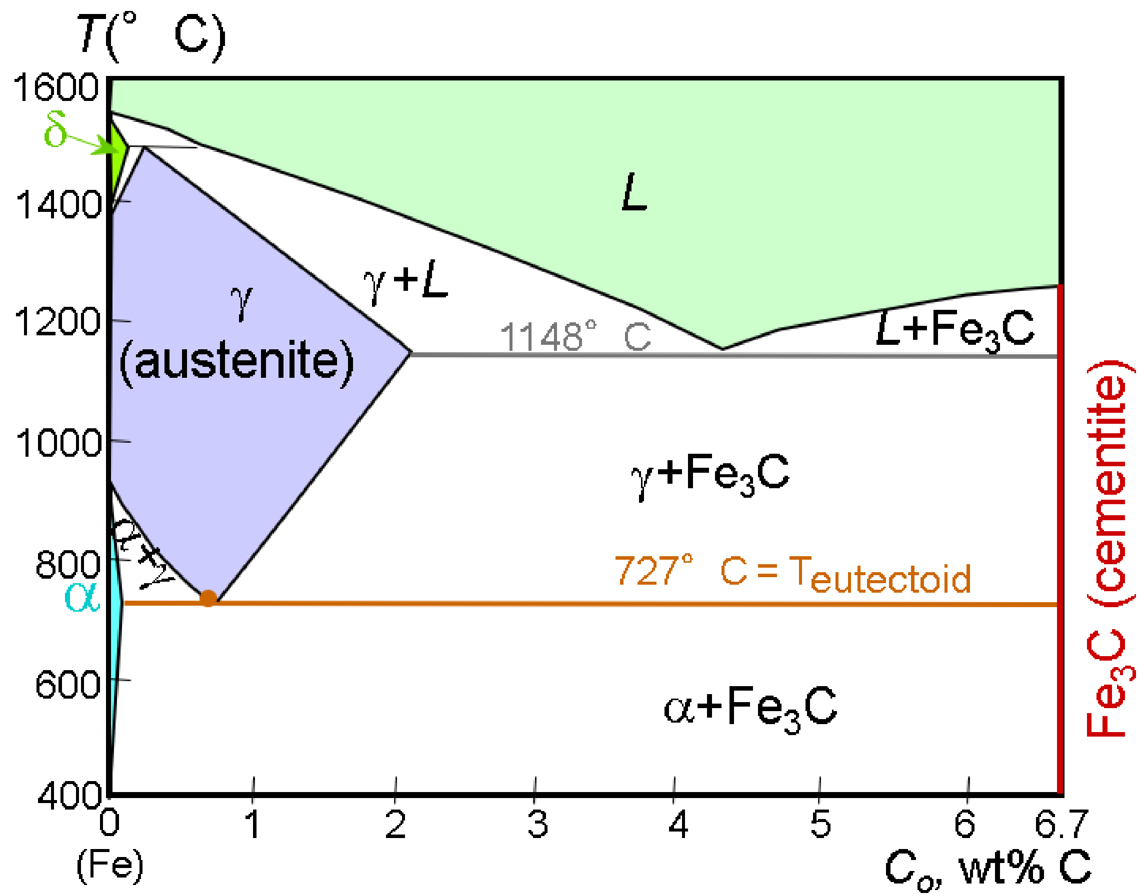
Q1. Consider 1.0 kg of austenite containing 1.15 wt% C, cooled to below 725°C (998 K).

(a) What is the proeutectoid phase?

(b) How many kilograms each of total ferrite and cementite form?

(c) How many kilograms each of pearlite and the proeutectoid phase form?

(d) Schematically sketch and label the resulting microstructure.



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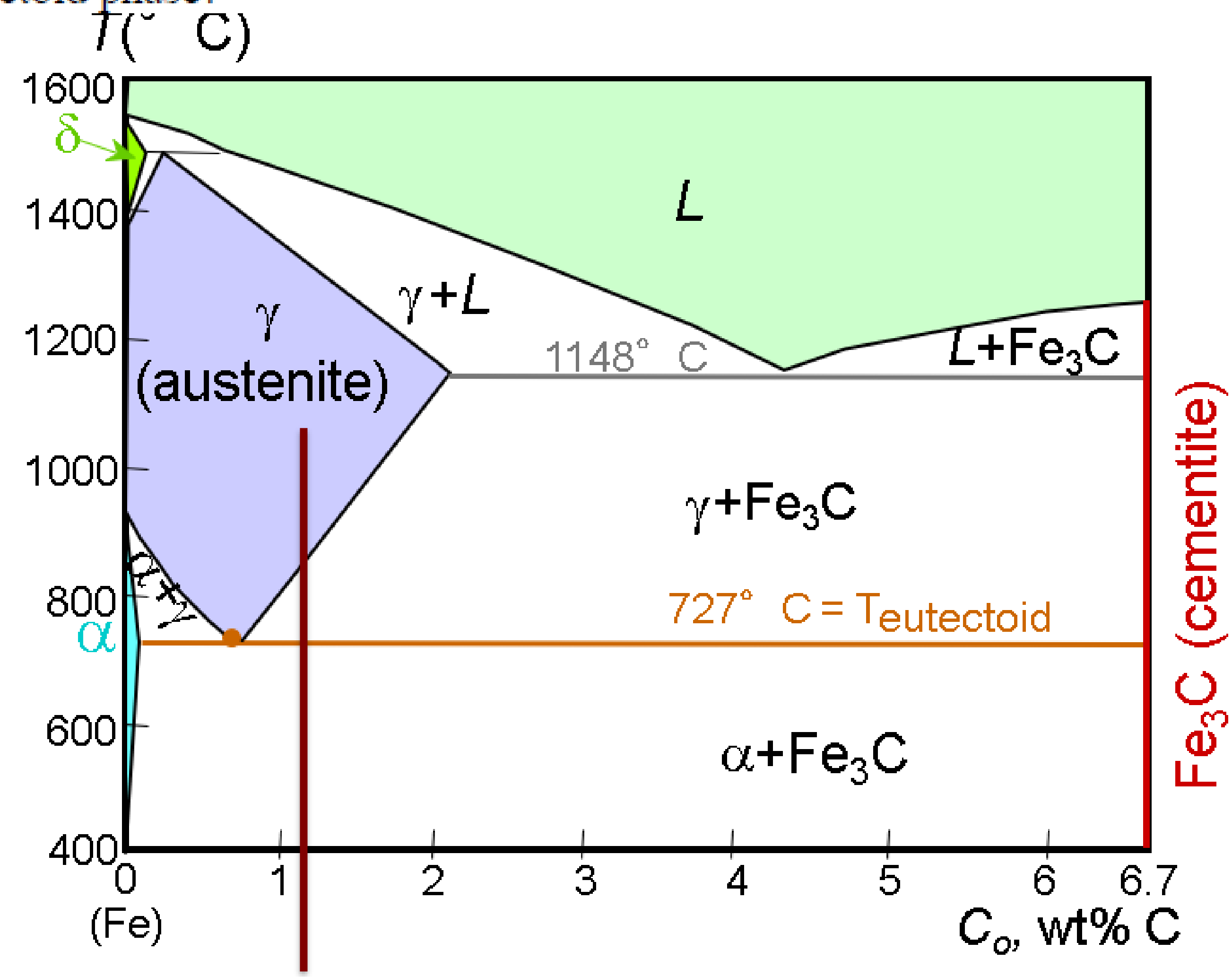

(a) The proeutectoid phase will be Fe_3C since 1.15 wt% C is greater than the eutectoid composition (0.76 wt% C).

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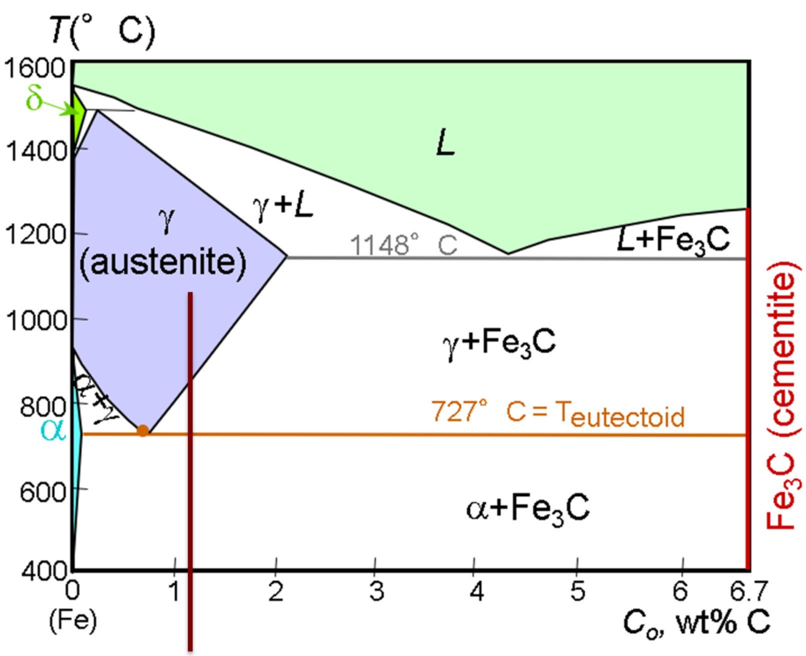

(b) For this portion of the problem, we are asked to determine how much total ferrite and cementite form. Application of the appropriate lever rule expression yields

$$W_\alpha = \frac{C_{Fe_3C} - C_0}{C_{Fe_3C} - C_\alpha} = \frac{6.70 - 1.15}{6.70 - 0.022} = 0.83$$

which, when multiplied by the total mass of the alloy (1.0 kg), gives 0.83 kg of total ferrite.

Similarly, for total cementite,

$$W_{Fe_3C} = \frac{C_0 - C_\alpha}{C_{Fe_3C} - C_\alpha} = \frac{1.15 - 0.022}{6.70 - 0.022} = 0.17$$

And the mass of total cementite that forms is (0.17)(1.0 kg) = 0.17 kg.

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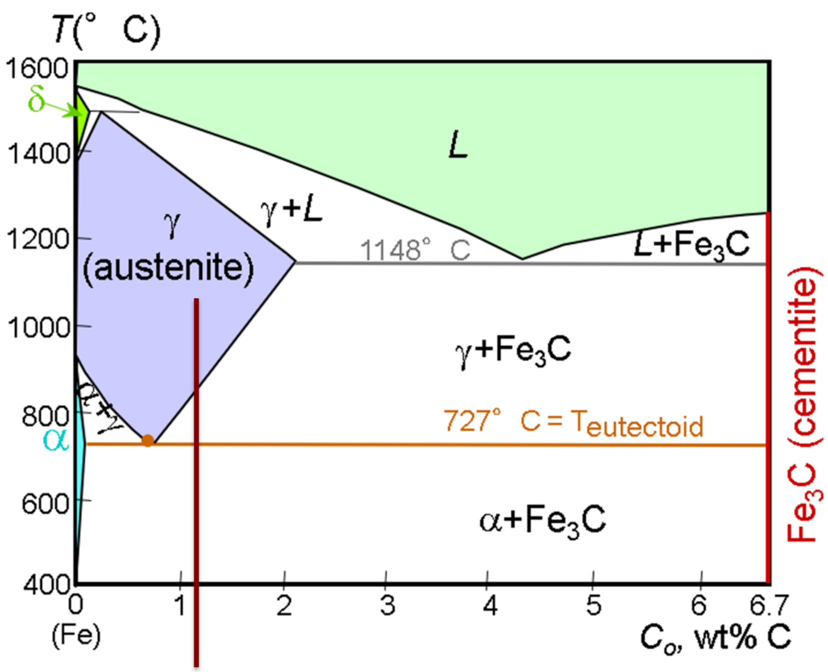

$$W_p = \frac{6.70 - C_1'}{6.70 - 0.76} = \frac{6.70 - 1.15}{6.70 - 0.76} = 0.93$$

which corresponds to a mass of 0.93 kg. Likewise, from Equation 9.23

$$W_{Fe_3C'} = \frac{C_1' - 0.76}{5.94} = \frac{1.15 - 0.76}{5.94} = 0.07$$

which is equivalent to 0.07 kg of the total 1.0 kg mass.

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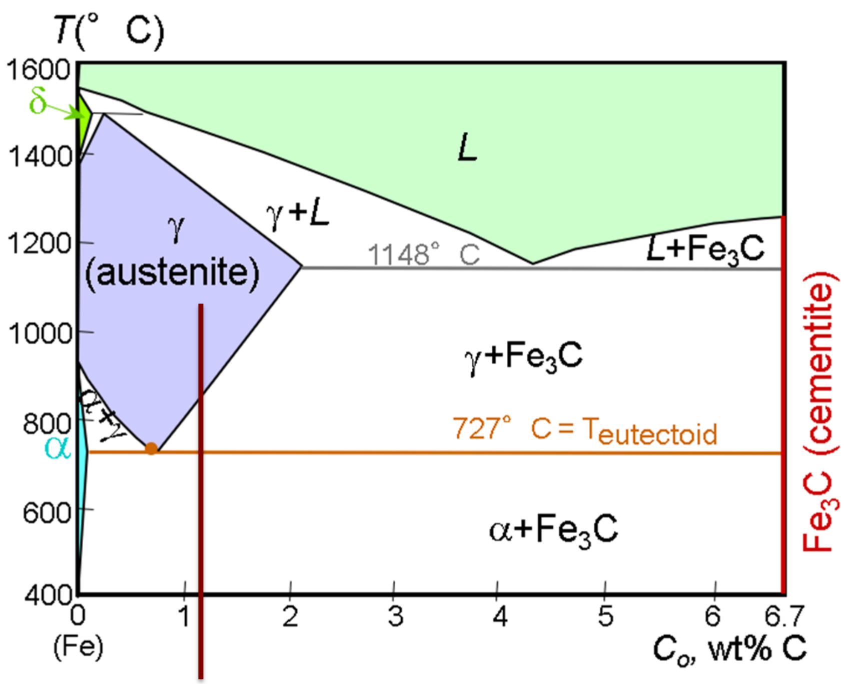
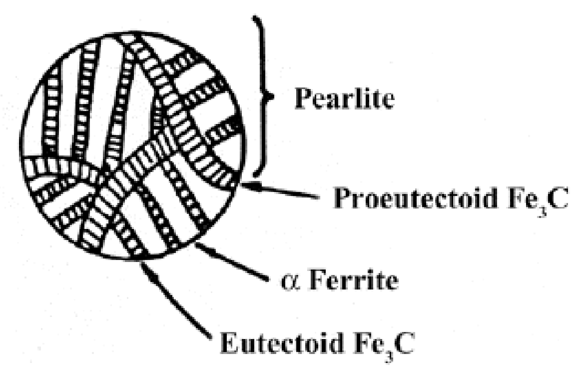
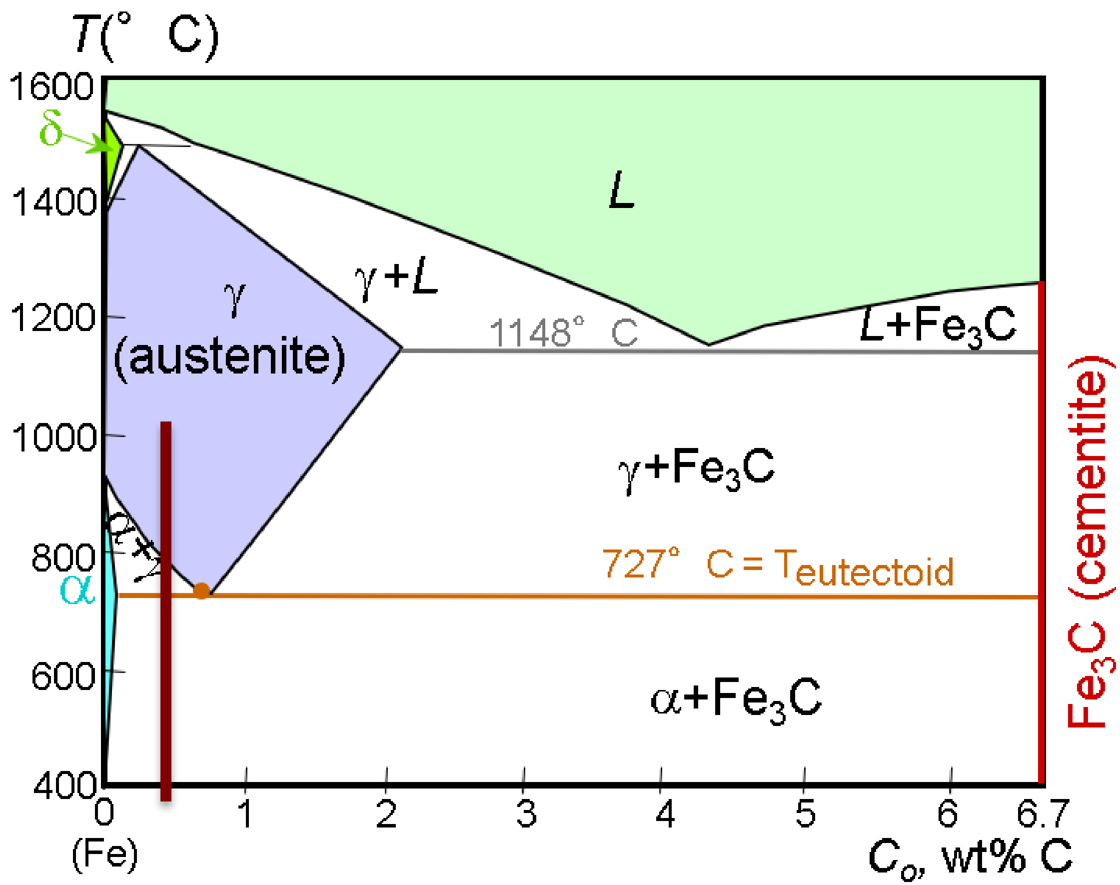


(d) Schematically, the microstructure would appear as:



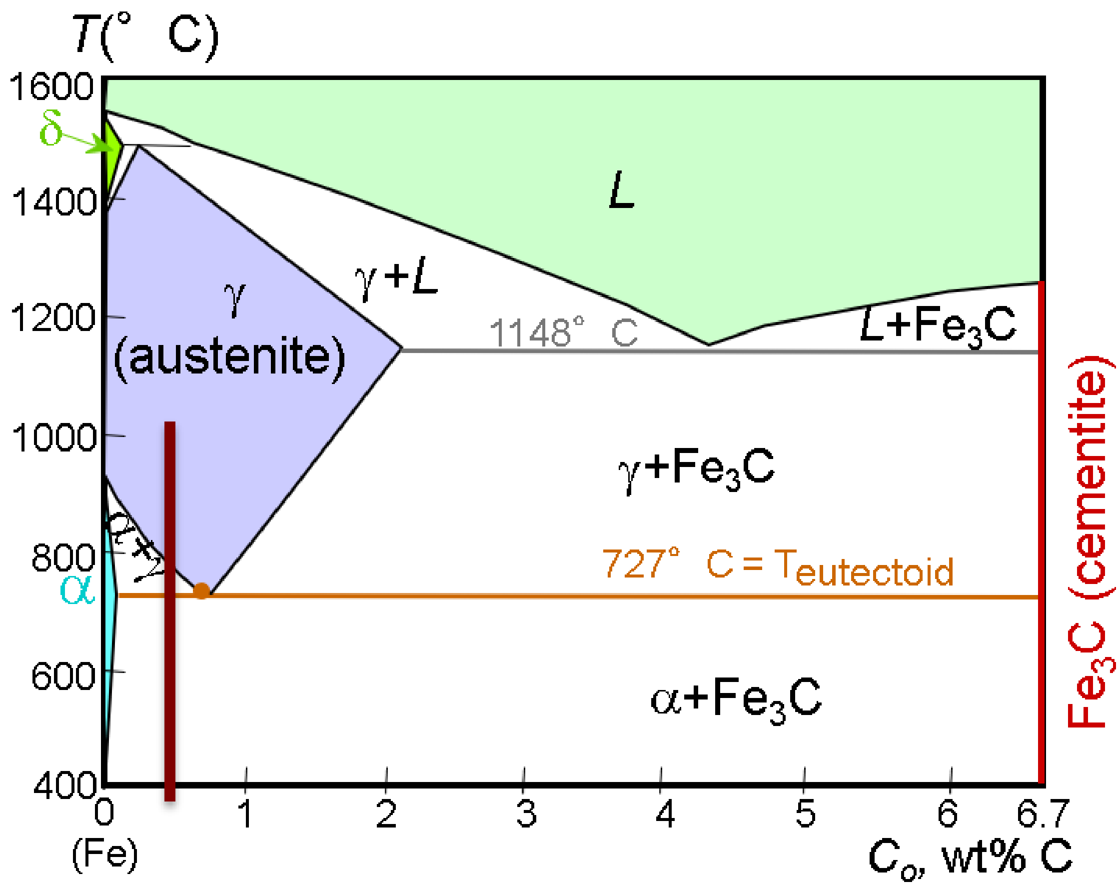
Q2. The microstructure of an iron–carbon alloy consists of proeutectoid ferrite and pearlite; the mass fractions of these two microconstituents are 0.280 and 0.720, respectively. Determine the concentration of carbon in this alloy.



$$W_p = 0.720 = \frac{C_0' - 0.022}{0.74}$$

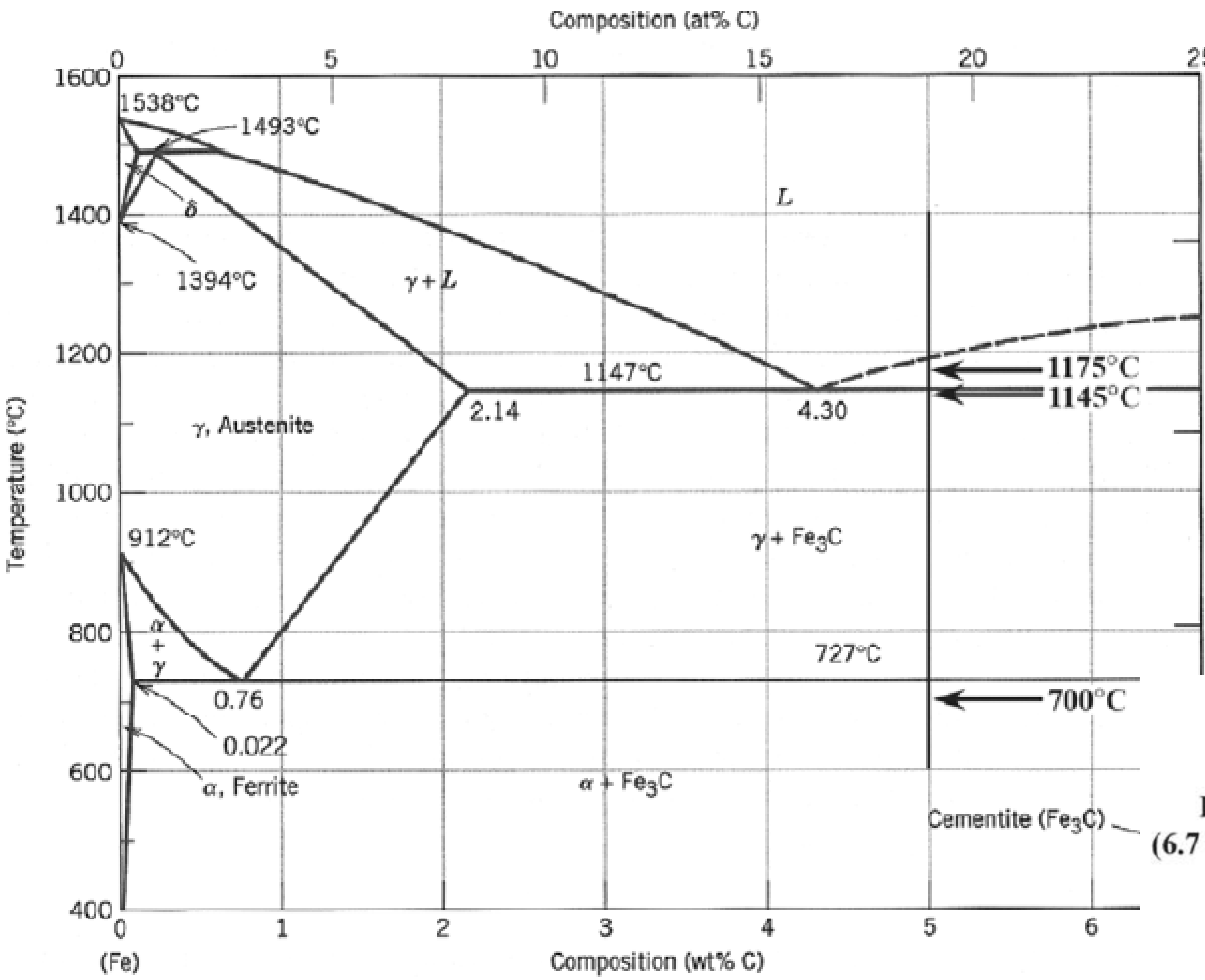
which yields $C_0' = 0.55$ wt% C.

Q3. Compute the mass fraction of eutectoid ferrite in an iron–carbon alloy that contains 0.45 wt% C.

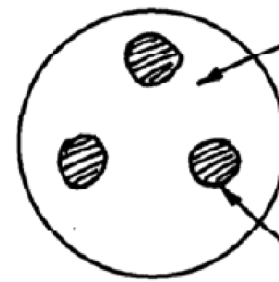


SOLVE THIS QUESTION BY YOURSELF ☺

Q4. For an iron–carbon alloy of composition 5 wt% C–95 wt% Fe, make schematic sketches of the microstructure that would be observed for conditions of very slow cooling at the following temperatures: 1180°C (1453 K), 1145C, and 700°C (973 K). Label the phases and indicate their compositions (approximate).



1180°C (1453 K)



L (4.7 wt% C)

Fe_3C (6.7 wt% C)

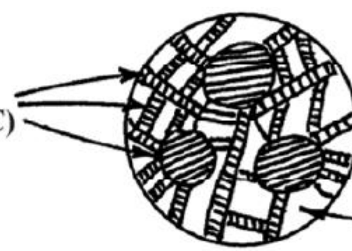
1145

Fe_3C (6.7 wt% C)

γ (2.14 wt% C)

700°C (973 K)

Fe_3C (6.7 wt% C)



α (0.022 wt% C)