

National Examination, May 2005

Met-B6, Physical Metallurgy of Iron and Steel

3-Hour Duration

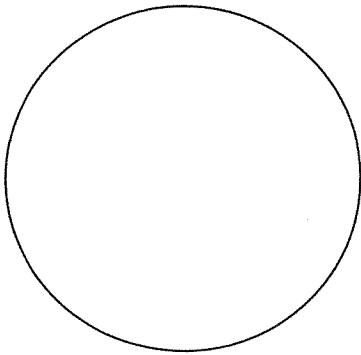
NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper with a clear statement of any assumptions made.
2. Candidates may use one of two calculators, the Casio or Sharpe approved models.
3. This is a *Closed Book* exam.
4. There are totally 6 questions. You must answer all of them.

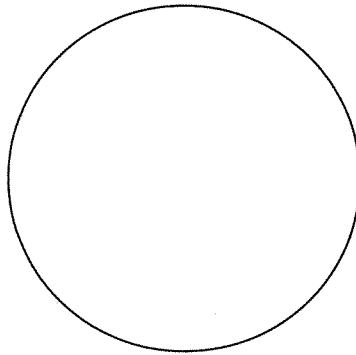
- I. (i) 12 marks, (ii) 8 marks.

In the circles provided below,

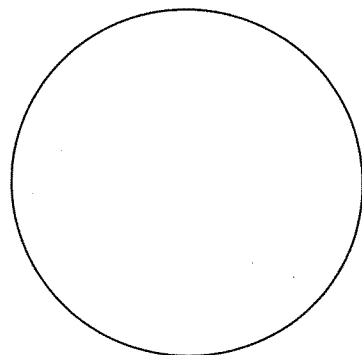
- (i) Draw schematically the microstructure of the SAE 1040 steel held at the following temperatures, respectively, for a relatively long period of time: (a) the microstructure at 1000°C , (b) the microstructure at 750°C and (c) the microstructure at 20°C after it is slowly cooled down from 750°C .
- (ii) Draw schematically the microstructure of the SAE 1090 steel held at the following temperatures, respectively, for a relatively long period of time: (a) the microstructure at 730°C , (b) the microstructure at 20°C after it is slowly cooled down from 730°C .



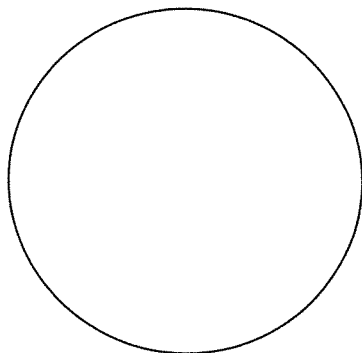
I – (i) – (a)



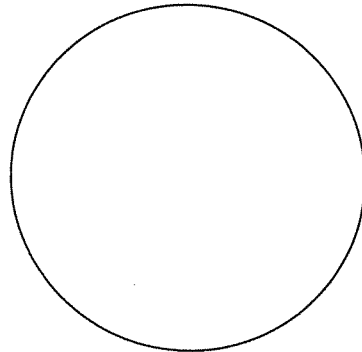
I – (i) – (b)



I – (i) – (c)



I – (ii) – (a)



I – (ii) – (b)

- II. (i) 7 marks. (ii) 8 marks.
- (i) Describe step by step how you would experimentally construct a *CCT* curve for a given steel.
- (ii) Explain the reason(s) qualitatively behind the “C” shape of a typical *TTT* curve, i.e. explain why a typical *TTT* curve has a “C” shape.

III. (i) 5 marks, (ii) 5 marks, (iii) 5 marks.

- (i) What is the driving force for a martensitic transformation in steel?
- (ii) What is the phase-transformation micro-mechanism of martensite formation in steel?
- (iii) Why does the hardness of martensite increase with increasing C content for most structural steels?

IV. (i) 7 marks, (ii) 8 marks

- (i) For many tool steels, such as D2, quenching can be done in air, i.e., for quenching, the work piece needs only to be taken out of the high temperature furnace and be put in air. Why is such a processing procedure recommended?
- (ii) In addition, for these steels, there is a general requirement to temper the steel after quenching a minimum of three times. Why?

V. (i) 3 marks, (ii) 3 marks, (iii) 3 marks, (iv) 6 marks.

(i) What is the chemical form and morphology of carbon in conventional gray cast irons?

(ii) What is the chemical form and morphology of carbon in white cast irons?

(iii) What are the contributing or determining factors in the carbon chemical form and morphology in these two types of cast irons?

(iv) How would you produce white cast irons?

VI. (i) 5 marks, (ii) 5 marks, (iii) 5 marks, (iv) 5 marks.

In the modern manufacturing, especially auto-manufacturing, industry, the following newly developed steels are being used more and more frequently for their respective special properties.

Please provide the full names for these steels, and briefly explain the significance of these names, respectively.

- (i) TRIP steels,
- (ii) DP steels,
- (iii) IF steels,
- (iv) HSLA steels.