Examples of examination questions
WB3310 Extractive metallurgy

This examination contains 5 questions with total of 70 points. This accounts for 70% of the total evaluation of the course. The rest 30% is accounted for by one report from the case study.

1: General questions   *(15 points)*

(1) What are typical feed preparation operations? What types of chemical reactions are involved?   (5 points)

(2) What is sintering and sintering roasting? What kinds of ores are suitable for sintering, and what kinds of ores are suitable for sintering-roasting? Please indicate the main difference between these two, using examples of ores.
                                                                         (5 points)

(3) What types of metallurgical diagrams do you know? How they are used in metallurgical operations?   (5 points)

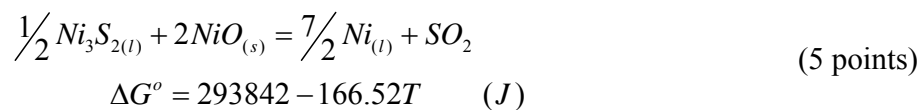## 2: Ironmaking and steelmaking   *(15 points)*

(1) Please describe how metallic iron (hot metal) is produced in Blast Furnace Process. Please also state: the raw materials, main chemical changes of feed along the movement in the furnace, various zones of the blast furnace, and different products of smelting operation. What are the roles of metallurgical coke in ironmaking blast furnace process?   (7,5 points)

(2) What are the main impurities in steelmaking process (brought by both hot metal and steel scrap)? How are they removed from the steel melt? What are the main differences between BOF and EAF steelmaking processes? Please state why do we use the steel scrap as part of the raw materials in BOF steelmaking.

                                                                         (7.5 points)

3: Sulphide smelting and refining   *(10 points)*

(1) Please describe the main extraction and refining steps and their functions of copper-making process from sulphide ore: from concentrates to refined copper as final metal product. Please also write down the main chemical reactions, the raw materials and products (Cu grade also) as well as wastes for each individual step.

(5 points)

(2) Sulphide smelting of nickel is similar to sulphide smelting of copper. However, during nickel converting in practice, only high grade nickel matte (Ni_3S_2) is produced instead of metallic nickel. Metallic nickel is produced in the end through electrolysis of nickel sulphide.

- *Please use the thermodynamic data below to calculate the minimum converting temperature from nickel matte to metallic nickel.*

- *Please explain why it is neither appropriate nor advisable to convert nickel matte directly to metallic nickel in a conventional P-S converter?*

Note that the melting point of nickel (Ni), nickel oxide (NiO), and nickel sulphide (Ni_3S_2) are: 1455^oC, 1955^oC and 789^oC, respectively.

$$\tfrac{1}{2} Ni_3S_{2(l)} + 2NiO_{(s)} = \tfrac{7}{2} Ni_{(l)} + SO_2$$

$$\Delta G^o = 293842 - 166.52T \qquad (J)$$

(5 points)

4: Hydrometllurgical processes and electrometallurgy   *(15 points)*

(1) Please describe the unit operation for _hydrometallurgical_ extraction of zinc metal from its sulphide concentrates (if it involves a non-hydrometallurgical operation, please describe it also). Please write down the main chemical reactions, major raw materials and products/by-products.   (5 points)

(2) What are electro-winning and electro-refining operations? Please use zinc to explain the electrowinning and copper for electro-refining processes in sulphate solution systems.   (5 points)

(3) What is molten salt electrolysis, and where it is used for metals extraction? What are the differences compared to electrowinning of metals in aqueous solutions

(5 points)

5: Phase diagrams   *(15 points)*
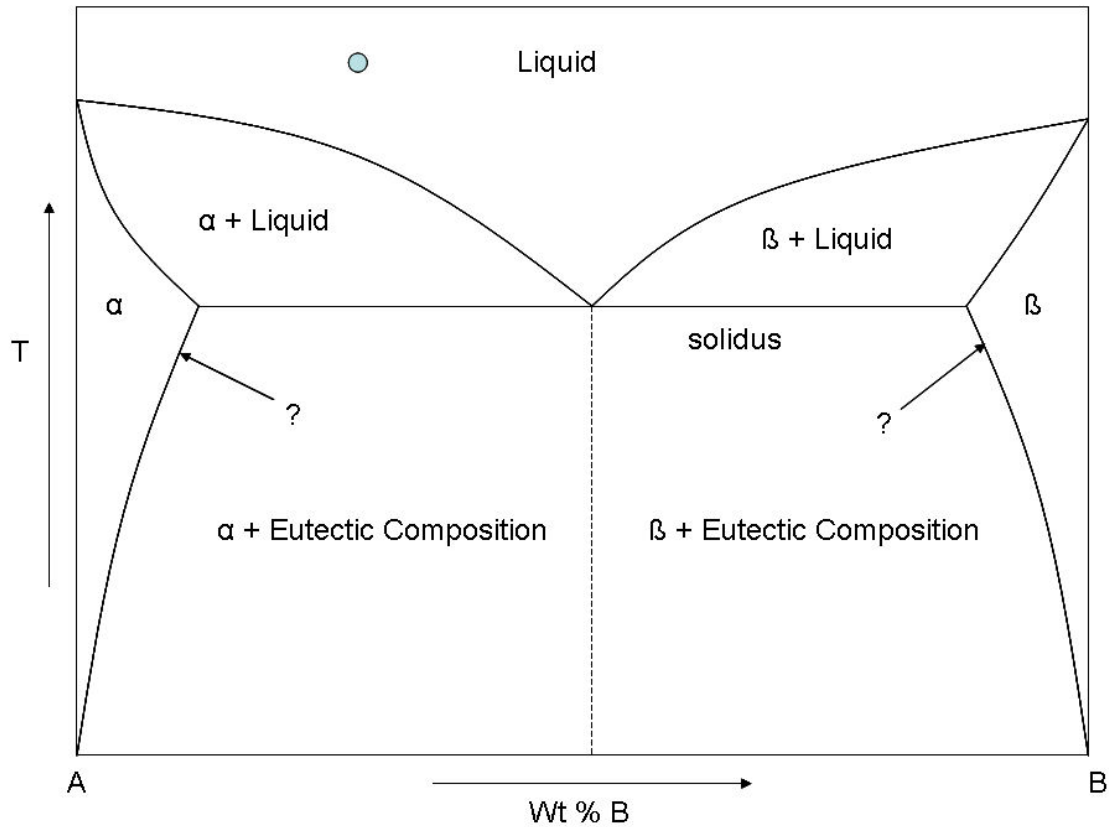
a) What is the name of the lines indicated by the question mark ? Choose from:
solidus, liquidus, solvus, eutecticum, peritecticum.
b) Indicate the crystallization behaviour of the melt composition indicated by the
blue dot. Please draw this on a separate paper (provided).
c) Is it possible to crystallize pure β ? If your answer is yes, what could be the melt
composition(s) from which this happens? If your answer is no, explain why it is
not possible.
d) Can I produce the pure eutectic composition in this system ? Explain your answer.

Rating of the questions a) to d).

a) 1.5 point;   b) 4.5 points,   c) 4.5 points,   d) 4.5 points