

CHEM-E6130 - Metal Recycling Technologies

Online Exam 14.12.2021, at 9-13,

Student name:

Study number:

The exam is an open book exam, where all printed and electronic material is allowed. The course content is divided into five topics each topic giving maximum 12 points.

Write your answer in this same Word file.

The completed exam (as a Word file) needs to be submitted until 13:00 on same day (14 December 2021). Before submission, please rename the Word file with your name. The submission box is in section 'Final exam' on MyCourses web page.

Topic 1 – General topics and raw materials.

Question 1-1. How would you explain the concept of sustainable development to a layman. Explain what kind of impact metal production may have on sustainability (write at least 3 examples of negative and positive impact). (6 points)

Question 1-2. Explain the concepts of industrial ecology and explain the connection between industrial ecology and circular economy. (6 points)

Topic 2. – Mechanical Processing.

Question 2-1 Explain the concept of liberation in mechanical processing. What methods are available to liberate waste electronic equipment? (6 points)

Question 2-2. What mechanical processing steps would you use to turn an end-of-life smartphones to separate different material streams? (6 points)

Topic 3. – Pyrometallurgy

Question 3-1. Challenges of using scrap as raw material in low alloy steel and stainless steel production. Means to cope with the challenges. (6 points)

Question 3-2. Your task is to recycle copper-containing shredder scrap containing antimony, lead and aluminium as impurities. What kind of pyrometallurgical processes would you use and why? How these impurities behave in the processes you choose? Is it possible that some of these impurities cause problems in processes or further processing of products? (6 points)

Topic 4. – Hydrometallurgy

Question 4-1. What alternatives do you have in using WEEE feed material in a traditional smelter – converter – electrorefining process for producing copper? What limits can you have? Is it possible to recover gold or silver from printed circuit boards using the copper production process and how? (6 points)

Question 4-2. Considering steel scrap, what possible tramp elements can be found in whiteware, that is large household appliances like washing machines, and how could you treat or remove them by hydrometallurgical methods? (6 points)

Topic 5. – LCA and Recycling as business

Question 5-1. What is the Functional Unit in LCA analysis? What is done in the LCI and LCIA phases of the LCA analysis? (4 points)

Question 5-2. You are given a task to compare a new cyanide-free gold leaching method of WEEE to traditional cyanide leaching, both will be followed by adsorption of gold into carbon and melting. How would you define the Functional Unit for LCA analysis? What factors would you include in the LCI phase of the analysis? (6 points)

Question 5-3. In WEEE treatment process, what is the most important step to improve metals recovery and why? (2 points)