



**NAMIBIA UNIVERSITY  
OF SCIENCE AND TECHNOLOGY  
FACULTY OF ENGINEERING AND SPATIAL SCIENCES  
DEPARTMENT OF MINING AND PROCESS ENGINEERING**

<b>QUALIFICATION: BACHELOR OF ENGINEERING IN METALLURGY</b>	
<b>QUALIFICATION CODE: 08BMET</b>	<b>LEVEL: 7</b>
<b>COURSE CODE: PDF711S</b>	<b>COURSE NAME: PHASE DIAGRAMS AND FORMING PROCESSES 314</b>
<b>SESSION: JUNE 2022</b>	<b>PAPER: THEORY</b>
<b>DURATION: 2 HOURS</b>	<b>MARKS: 65</b>

<b>SECOND OPPORTUNITY QUESTION PAPER</b>	
<b>EXAMINER(S)</b>	<b>Mrs. Jaquiline Tatenda Kurasha</b>
<b>MODERATOR:</b>	<b>Professor Sofya Mitropolskaya</b>

<b>INSTRUCTIONS</b>
<ol style="list-style-type: none"><li>1. Answer all questions.</li><li>2. Read all the questions carefully before answering.</li><li>3. Marks for each question are indicated at the end of each question.</li><li>4. Please ensure that your writing is legible, neat and presentable.</li></ol>

**PERMISSIBLE MATERIALS**

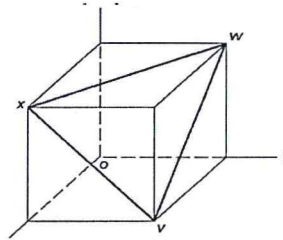
1. Examination paper.
2. Non-programmable calculator.

**THIS QUESTION PAPER CONSISTS OF 4 PAGES (Including this front page)**



**Question 1 (15 Marks)**

- (a) What is the stacking sequence of the BCC crystal structure. Explain your answer. [2]
- (b) Consider the diagram below. Determine the miller indices of
- (i) plane  $vwx$  [2]
  - (ii) direction  $xv$ . [1.5]
  - (iii) direction  $vw$ . [1.5]

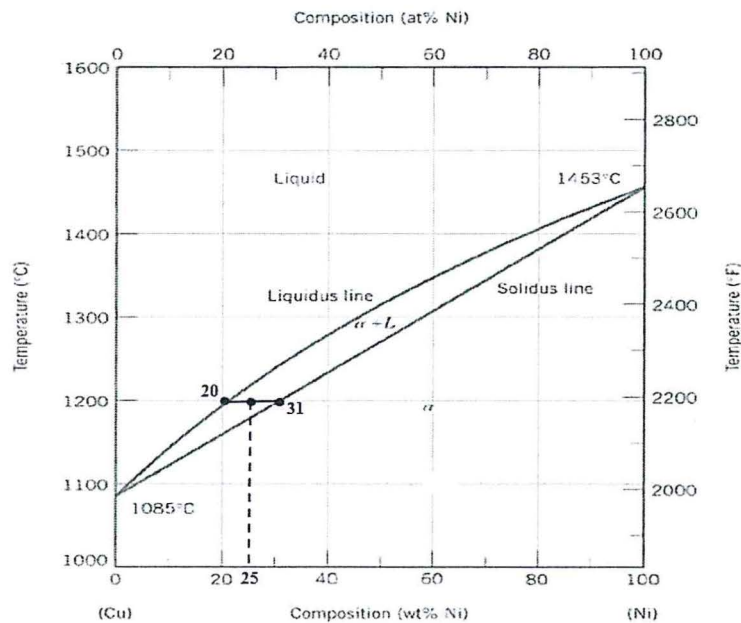


- (c) Copper and gold both have an FCC crystal. Will they produce the same x-ray diffraction pattern? Explain your answer. [2]
- (d) A beam of X-rays of wavelength 0.071 nm is diffracted by the (110) plane of a nickel sample with lattice constant of 0.353 nm.
- (i) Find the angle at which second-order diffraction takes place. [2]
  - (ii) Calculate the interplanar spacing. [2]
- (e) The size of Brinell indentation taken on a steel specimen was found to be 6mm. Diameter of the ball indenter is 10mm. Estimate its hardness. The test load was 2000kg. [2]

**Question 2 (15 marks)**

The diagram below shows the copper-nickel phase diagram.

- (a) Comment on the solubility of the two elements in each other, and explain your answer. [2]
- (b) What type of solid solution is formed in this alloy system. Comment on your answer. [2]
- (c) If Nickel is alloyed with silver, will a similar phase diagram be generated? Explain your answer. [2]
- (d) Consider a Cu-25Ni alloy.
  - (i) Sketch the cooling curve for the alloy given that the pouring temperature during casting is 1300°C. [3]
  - (ii) Calculate the degrees of freedom, and comment on your answer. [2]
  - (iii) Calculate the phase fractions. [4]



### Question 3 (15 Marks)

- (a) Explain why forged components have better strength and toughness compared to components made from other forming processes. [2]
- (b) (i) One way of classifying forging operations is by considering the force application. By this classification, name and briefly describe the two ways deformation force is applied. [2]  
(ii) Why is a flash required in impression die forging? [1]
- (c) A hot upset forging operation is performed in an open die. The initial height and diameter of the workpiece are 50mm and 25mm respectively. At the end of the stroke, the average diameter of the workpiece is 50mm, and the flow stress is 85MPa. The coefficient of friction at the die-work interface is 0.4.  
(i) Calculate the height of the work piece at end of the stroke. [2]  
(ii) Calculate the forging force at the end of the stroke. [3]
- (d) (i) Name and briefly describe the three main types of extrusion operations. [3]  
(ii) Explain how to can ensure that all the material is extruded, i.e. minimal off-cut. [2]

### Question 4 (20 Marks)

- (a) The strength of the welded joint depends on faying surfaces. Explain this statement, and explain what faying surface means? [2]
- (b) Name and distinguish between the two broad types of electrodes used in arc welding. [4]

- (c) Distortion/warping is a serious problem in fusion welding. Suggest three ways to minimize distortion. [3]
- (d) With the aid of a diagram, explain what heat affected zone (HAZ) means in fusion welding, and describe the microstructure observed in the HAZ. [3]
- (e) Mechanical joining is generally classified as non-permanent joining.
- (i) Give one exception to this classification and suggest three circumstances under which the exception is used. [4]
- (ii) Give two advantages and two disadvantages of mechanical joining. [4]

**End of Question Paper.**

