INSTRUCTIONS:

1. ALL questions should be attempted, except for Question 4 where you may choose between answering questions a, b, d and e OR b, c, d and e.

2. Any programmable or non-programmable calculator may be used provided it has been cleared of any information that would subvert the purpose of the examination.

3. Calculations must be shown in sufficient detail to illustrate your understanding of the procedure.
QUESTION 1 – SA Pulp and Paper Industry

a) List two hardwoods used in the South African paper industry  

b) Name two mills in RSA that produce dissolving pulp (chemical cellulose).  

c) Which country has the largest forest area in the world?  

d) Why is there limited area available in South Africa for growing plantation trees?  

e) What makes the digital storage of data energy intensive compared to paper?  

f) Given a choice between woodfree printing paper and SGW printing paper, which would you expect to have lowest lifecycle environmental impacts? Give reasons for your answer  

TOTAL /11/  

QUESTION 2 – The Nature of Wood  

a) Define fibre coarseness.  

b) Is low or high coarseness better for pulp tensile strength? Explain  

c) If I was to compare a fibre to a plastic drinking straw, what natural polymer would make up the majority of the straw wall?  

d) Characterise the polymer in the answer the Question 2(c) in terms of its molecular structure and characteristics.  

TOTAL /9/
QUESTION 3 - Woodyard

a) True or False?

i. Modern mills store logs for up to 10 - 14 days' supply of wood  (1)

ii. Chips are usually stored in outside piles  (1)

iii. Long storage in the woodyard results in decreased bleaching costs  (1)

iv. Wood moisture after storage is typically 55% - 60%  (1)

v. Dry wood decreases the frequency of maintenance and sharpening of the chipper blades  (1)

b) List the differences between a conventional drum debarker and the gentle barker.  (3)

c) What usually happens to the bark from the logs after debarking?  (1)

d) What dimension of the wood chip is the most important control variable for chemical pulping?  (1)

TOTAL /10/
QUESTION 4 – Kraft and Sulphite Pulping (Choose between answering Q4 a, b, d and e or Q4 b, c, d and e)

a) Compare the Kraft and sulphite pulping processes in terms of process conditions and pulp qualities.  

(6)

b) A white liquor is mixed in a laboratory. The caustic soda concentration is 11.2 g/l as NaOH and the sodium sulphide concentration is 7.3 g/l as Na₂S. Calculate the AA and EA (expressed as Na₂O) and Sulphidity of this liquor.  

(8)

c) With the aid of diagrams explain the differences (equipment and process) between EMCC and Compact cooking.  

(6)

d) Which of the two cooking processes in Question 4(c) would you consider to be better from a cleaner production point of view? Explain why.  

(2)

e) Given the choice between installing a Ca-based or a Mg-based sulphite cooking process, which would you choose to ensure the lowest environmental impact? Give reasons for your choice.  

(3)

TOTAL /19/
QUESTION 5 – Washing, screening and cleaning

a) If a pulp washer used in the production of dissolving pulp has a dilution factor of 9.5, what does this mean? Explain what is meant by dilution factor. (3)

b) Given the task of measuring the efficiency of a brown stock washer, how would you perform this task? (4)

b) Why are screens and cleaners installed in a cascade arrangement? Draw a 3-stage cascade screening arrangement. (4)

TOTAL /11/

QUESTION 6 – Kraft Recovery

a) Draw and label a graph showing how viscosity of black liquor changes with a change in solids concentration at two different temperatures. (4)

b) What type of treatment can be used to reduce viscosity in black liquor? (1)

c) What purposes do the following serve in a recovery boiler and furnace?

   i. a bull nose (1)

   ii. an economiser (1)

   iii. primary air (1)

d) What chemical conversions take place in the recausticizer? (2)

TOTAL /10/
QUESTION 7 – Bleaching

a) Using the figure provided below, list the labels for the x and y axes and explain what the graph demonstrates with respect to oxygen delignification. (4)

b) What chemical is added together with oxygen in the oxygen delignification process? (1)

c) As the Kappa number decreases through the various bleach stages it becomes more difficult and inaccurate to monitor the Kappa number. What other test is used to monitor pulp quality after each bleach stage? (1)

d) Briefly describe the test given in answer to Question 7(c) (3)

e) Give an example of a light ECF bleach sequence. (1)

f) What group of chemical compounds found in bleach plant wastewater resulted in the move away from chlorine as a primary bleaching agent in the 1980's? (1)

g) Draw a flow diagram showing the process units, chemicals added and point of addition for a DØ chlorine dioxide bleach stage. (4)

TOTAL /15/
QUESTION 8 – Mechanical and Semimechanical pulping

a) In which mechanical pulping process are logs pressed up against a rotating stone? (1)

b) What mechanism results in heat build up in the wood in the mechanical process referred to in Question 8(a)? (2)

c) How does heat build up assist in the pulping process? (2)

d) List three advantages of mechanical pulping (3)

e) What causes photo-yellowing in mechanical pulps? (1)

f) Explain what is meant by the term “photo-yellowing” (1)

TOTAL /10/
QUESTION 9 – Pulp Rheology

a) List the five flow regimes (A; A-B; B-C; C-D; D-H) found in pulp suspensions as the velocity increases, indicated on the diagram below:

![Diagram showing flow regimes A, A-B, B-C, C-D, D-H with labels Pulp and Water.](image)

Velocity, V

b) At which points are $V_{\text{max}}$ and $V_w$ found on the diagram shown in Question 9(a)?

(2)

c) At which velocity would you choose to operate a system pumping a pulp slurry at 4% consistency? Give reasons for your answer.

(2)

TOTAL /9/
Data Sheet

Atomic mass (AMU) of:

Na = 23
O = 16
H = 1
S = 32