ZIMBABWE

MINISTRY OF HIGHER AND TERTIARY EDUCATION, INNOVATION, SCIENCE AND TECHNOLOGY DEVELOPMENT

HIGHER EDUCATION EXAMINATIONS COUNCIL (HEXCO)

NATIONAL DIPLOMA

IN
FOOD SCIENCE AND TECHNOLOGY

MODULE: Food Engineering **PAPER NO: 544/23/M03**

DURATION: 3 Hours

JUNE 2026 EXAMINATION

REQUIREMENTS

Scientific calculator

INSTRUCTIONS TO CANDIDATE

1. **Answer any five (5) questions.**
2. **Do not write anything on the question paper.**
3. **Do not write your name on the answer booklet.**

This paper consists of 3 printed pages.

PAPER NO: 544/23/M03 - FOOD ENGINEERING

QUESTION 1

a) Describe three (3) modes of heat transfer. (9 marks)

b) Draw and label the phase diagram of water. (6 marks)

c) State five (5) types of freezers used in the food industry. (5 marks)

QUESTION 2

a) Predict the specific heat for a model with the following composition:

Carbohydrate 38%
Protein 18%, fat 14%, Ash 3%, Moisture 27%

$Cp = 1{,}423X_h + 1{,}549X_p + 1{,}675X_f + 0{,}837X_a + 4{,}187X_m$ (5 marks)

b) Describe dehydration methods with particular reference to

i) Belt drying (5 marks)

ii) Fluidised drying (5 marks)

iii) Atmosphere freeze drying (5 marks)

QUESTION 3

a) Describe flow patterns in fluid mixing in terms of:

i) Radial velocity (4 marks)

ii) Axial velocity (4 marks)

iii) Tangential velocity (4 marks)

b) Outline the pre-mixing treatment of various foods or ingredients. (8 marks)

QUESTION 4

a) Soya mince meat balls of diameter equal to 5cm are to be frozen in a cold air environment at -35°C. The meatballs have a density of 1150kg/m^3 water content equal to 76% and begin to freeze at a temperature of approximately -2°C .The thermal conductivity of frozen meat is 1,2 w/mk and the convective heat transfer coefficient for the meat ball is 20W/m^2k. Taking latent heat of freezing for water 334 kJ/kg estimate the time required to freeze meat ball. (10 marks)

b) Describe the operation of the following pumps

i) Centrifugal pump (5 marks)

ii) Rotary pump (5 marks)

QUESTION 5

a) With the aid of a diagram describe heat transfer by a double effect evaporator. (12 marks)

b) Explain factors that influence rate of heat transfer during freezing. (8 marks)

QUESTION 6

a) Discuss and explain factors influencing mixing. (6 marks)

b) Giving examples outline some applications of size reduction operations in the food industry. (10 marks)

c) Describe the effects of drying conditions on food quality. (4 marks)

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