THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2020 SECOND SEMESTER EXAMINATION

THIRD YEAR MINERAL PROCESSING ENGINEERING

MP322- PROCESS TECHNOLOGY II

DATE: FRIDAY 23RD OCTOBER, 2020

TIME: 8:20AM

VENUE: MN003

TIME ALLOWED: 3.0 HOURS

INFORMATION FOR STUDENTS

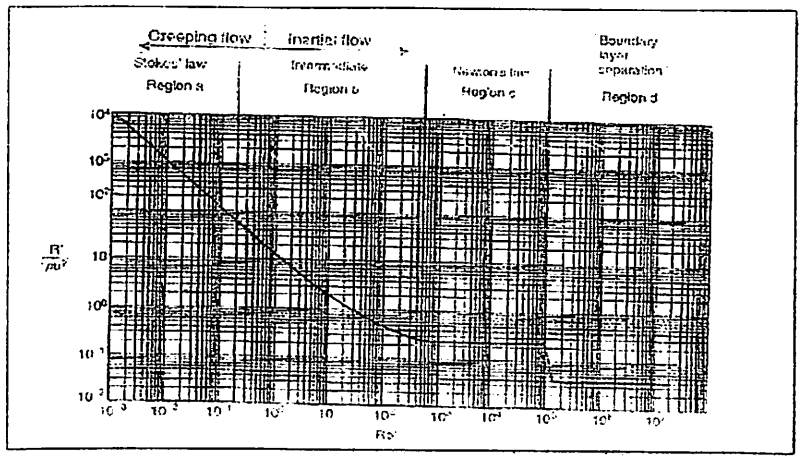
1. You have 10 minutes to read the paper. You **SHOULD NOT** write during this time.
2. There are **FIVE (5)** questions in this paper. Answer **ALL FIVE (5)** questions
3. Answer all questions in the answer books and graph papers provided. No other written material will be accepted.
4. Calculators and drawing equipment are permitted in the examination room. Notes, mobile phones, laptops and textbooks are not allowed.
5. WRITE YOUR **NAME** AND **ID NUMBER** CLEARLY ON THE ANSWER BOOK-DO IT NOW
6. Marks for each question are as indicated

QUESTION 1

a) Define the following;

I. Boundary layer
II. Laminar Boundary layer
III. Turbulent Boundary layer
IV. Drag Force
V. Reynolds Number
VI. Terminal falling velocity

b) Provided the graph below; briefly explain the four regions, a, b, c & d in relation to the Reynolds number.



Use the graph of $\left(\frac{R'}{\rho v_0^2}\right) Re'^2 / \left(\frac{R'}{\rho v_0^2}\right) Re'^{-1}$ vs Re' provided at the back to answer questions c and d;

c)

I. Calculate the terminal falling velocity of a bauxite particle of diameter 0.71 mm settling in water. Density of bauxite is 2600 kg/m^3.
II. Which region is the particle settling in?
III. Determine the total drag force acting on the particle

d)

I. Determine the diameter of a covellite particle settling in water at a settling velocity of 9cm/s. The density of covellite is 4700 kg/m^3.
II. Which region is the particle settling in?
III. Calculate the total drag force acting on the particle?

[6+4+5+5= 20 Marks]

QUESTION 2

a) State and briefly explain the factors that affect the thickening rate.

b) Provide the two (2) main functions of a thickener

c) Provide the two(2) main design requirements of a thickener

d) Batch settling tests at initial solids concentrations ranging from 10 to 40 kg solids/m^3 were carried out and results for the concentrations and fluxes are shown in the table below. The slurry had an initial concentration of 3kg solids/m^3. The thickener isrequired to give an underflow concentration of 150 kg/m^3 for a feed rate of 3 m^3/s of slurry.

Test	1	2	3	4
C (kg/m^3)	10	20	30	40
ψ (kg/m^2 s)	0.12	0.15	0.21	0.25

Use the Talmage and Fitch method to;

(I) Obtain the settling rate (R) values for each concentration

(II) Determine the values of $\left(\frac{\frac{1}{C}-\frac{1}{C_u}}{R}\right)$ for each concentration

(II) Calculate the area of the thickener to meet the design requirement

[6+2+2+10= 20 Marks]

QUESTION 3

a) State at least five (5) factors to be considered when selecting filtration equipment

b) Provide the five (5) factors the filtration rate

c) Give the four (4) main reasons for carrying out drying

d) State and briefly explain the three (3) types of drying processes

[5+5+4+6= 20 Marks]

QUESTION 4

Use the psychometric chart provided to answer the questions;

a) Provided the $T_{dry} = 40°C$ and the$T_{wet} = 25°C$, find;
   i. Relative Humidity (RH)
   ii. Dew point Temperature (T_{dp})
   iii. Humidity Ratio (HR)
   iv. Specific volume (V)
   v. Enthalpy (h)

b) During a heating and humidifying process, the dry bulb temperature was increased from 40°C to 50°C.If the wet bulb temperature before the increase is 25°C, determine the following from the psychometric chart;

(i) Draw this psychometric process on the chart indicating the various properties of air
(ii) The wet bulb temperature after the temperature increase(T_{w2})
(iii) The Humidity ratio before the temperature increase(HR_1)
(iv) The Humidity ratio after the temperature increase(HR_2)
(v) The Relative Humidity after the increase (RH_2)

[10+10 = 20 Marks]

QUESTION 5

a) State and briefly explain the three (3) modes of heat transfer and also provide the laws governing them

b) Provided the following information;

Material	Aluminium	Copper	Steel	Concrete
(k) W/m .°C	201	385	63	0.1

I. Determine the heat transfer rate per unit area of a steel plate 100mm long and 250mm wide having a thickness of 30mm. The surfaces have a temperature difference of 85°C.
II. Calculate the thermal resistance of the steel plate

c) The heat flux ($\dot{q}$) is 4000 W/m^2 at the surface of an electric heater. The heater temperature is 150°C and is cooled by air at 60°C. The heater is 300mm long and 450mm wide.

I. Determine the convective heat transfer coefficient (h)
II. Calculate the rate of heat transfer (Q)

d) A certain black body has a true surface area of 15 m^2 and an envelope area of 7 m^2. It has a surface temperature of 60°C and is situated in a dark room at 13°C. The surface heat transfer coefficient is 5.5 W/m^2 K.

Calculate;
I. The radiated heat transfer
II. The convected heat transfer rate
III. And the total heat transfer.

[6+4+4+6 = 20 Marks]

End of Paper

Formula Sheet:

$$\left(\frac{R'}{\rho {v_0}^2}\right) Re'^2 = \frac{2d^3(\rho_s - \rho)\rho g}{3\mu^2}$$

$$\left(\frac{R'}{\rho {v_0}^2}\right) Re'^{-1} = \frac{2\mu g}{3\rho^2 {v_0}^3}(\rho_s - \rho)$$

$$R' = \frac{2}{3} d(\rho_s - \rho)g$$

$$F = 3\pi\mu dv$$

$$F = 3\pi\mu dv\left(1 + 0.15Re'^{0.687}\right)$$

$$F = 0.055\,\pi d^2 \rho v^2$$

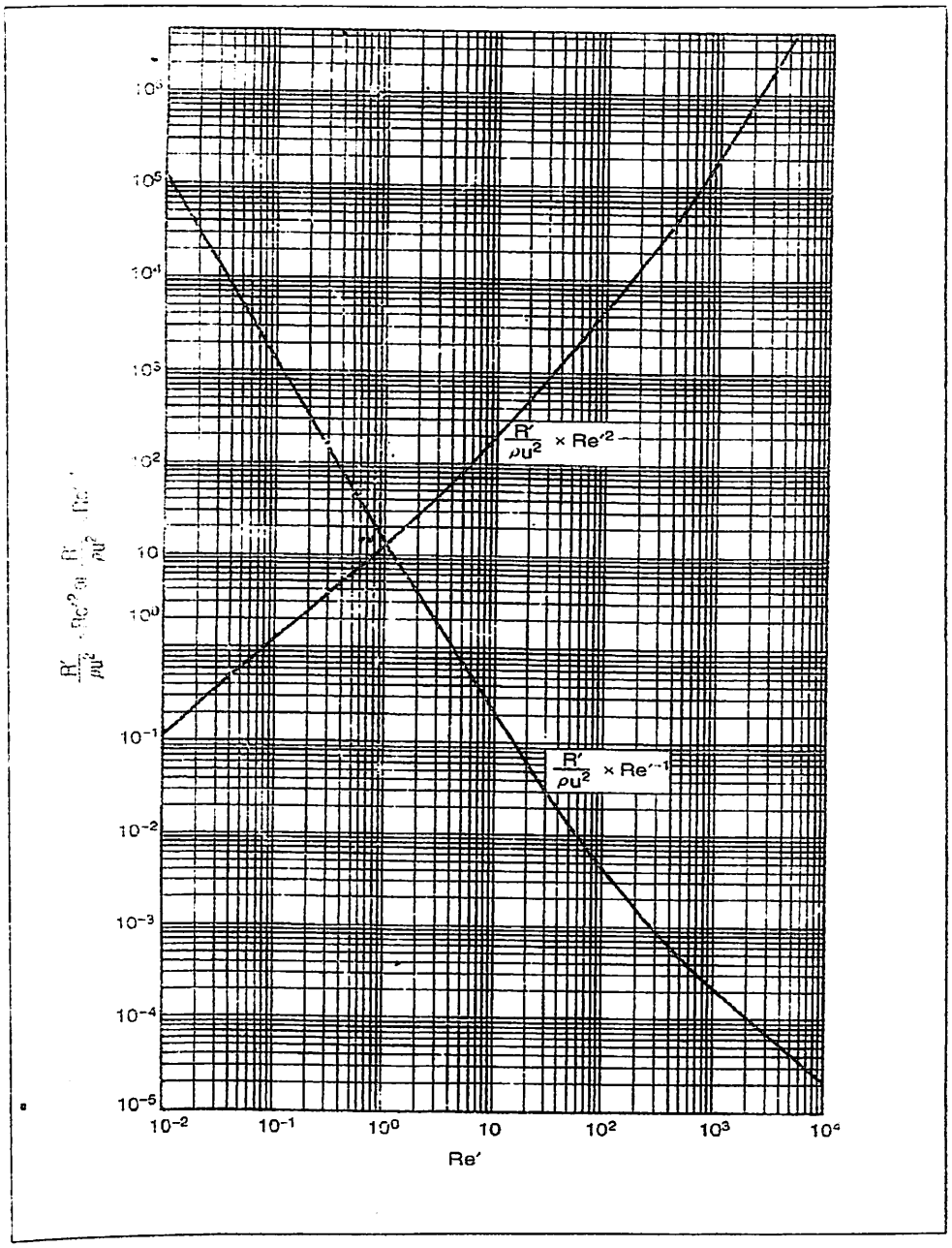
$$F = 0.0125\,\pi d^2 \rho v^2$$

$$A = \frac{\frac{1}{C} - \frac{1}{C_u}}{R} \times QC$$

$$Q = k.\frac{A.\Delta T}{L}$$

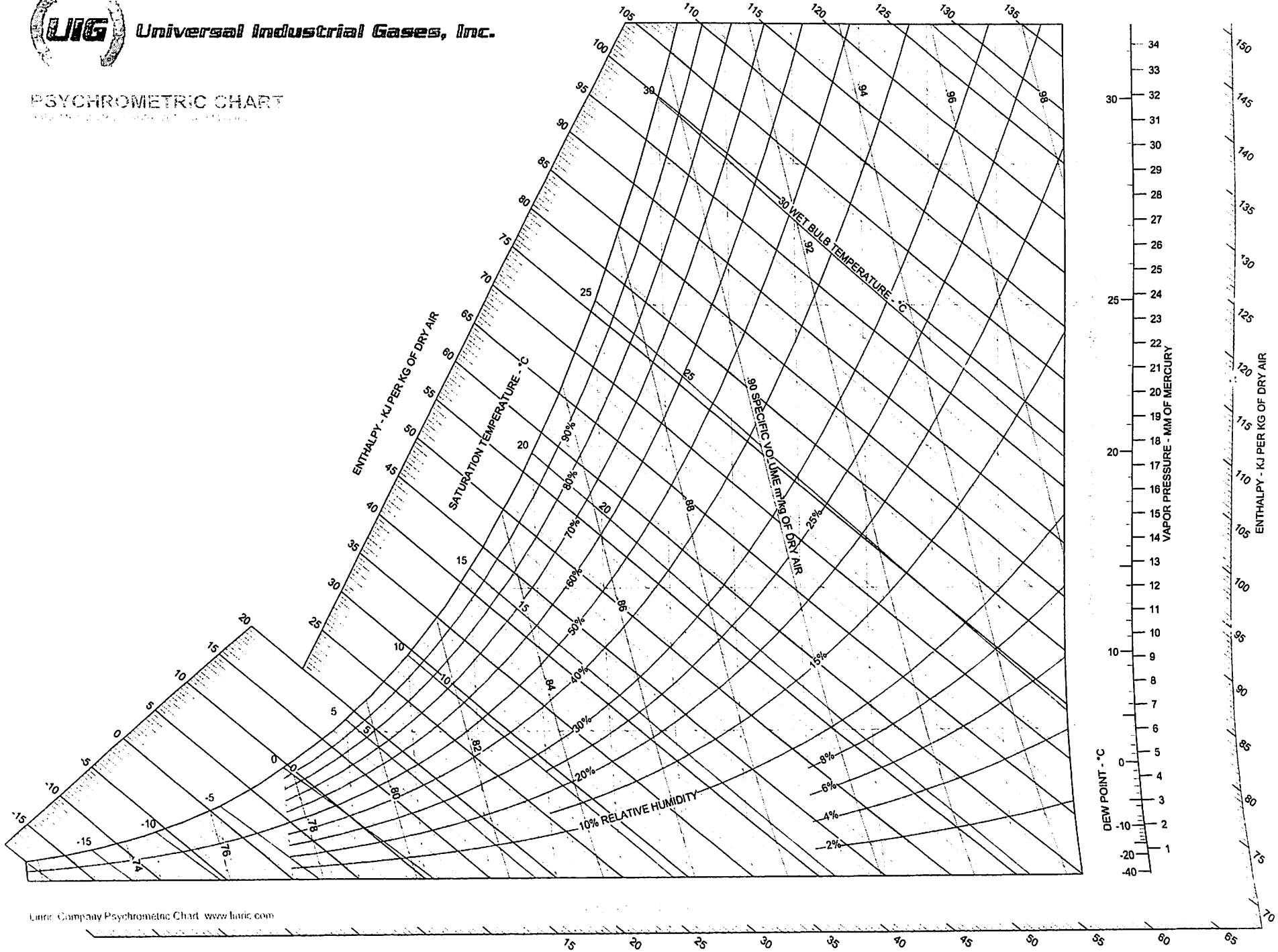
$$Q = A.h\left(T_s - T_f\right)$$

$$Q = \sigma.A.\left({T_1}^4 - {T_2}^4\right)$$


$\frac{R'}{\rho u^2} \times Re'^{-2}$
$\frac{R'}{\rho u^2} \times Re'^{-1}$
10^5
10^4
10^3
10^2
10
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-2}
10^{-1}
10^0
10
10^2
10^3
10^4
Re′

Universal Industrial Gases, Inc.

PSYCHROMETRIC CHART



Linric Company Psychrometric Chart www.linric.com