UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *CHEMICAL ENGINEERING*
SUBJECT	:	**CHEMICAL PLANT 3A**
CODE	:	**ACPA 321**
DATE	:	ASSA EXAMINATION
DURATION	:	
WEIGHT	:	40 : 60
TOTAL MARKS	:	100
EXAMINER(S)	:	MISS NOXOLO SIBIYA
MODERATOR	:	DR. A. MAMVURA
NUMBER OF PAGES	:	4 PAGES
REQUIREMENTS	:	Use of scientific (non-programmable) calculator is permitted (Only one per candidate)

HINTS AND INSTRUCTIONS TO CANDIDATE(S):

- Purpose of assessment is to determine not only if you can write down an answer, but also to assess whether you understand the concepts, principles and expressions involved. Set out solutions in a logical and concise manner with justification for the steps followed.
- **ATTEMPT ALL QUESTIONS**. Please answer each question to the best of your ability.
- Write your details (module name and code, ID number,student number etc.)on script(s).
- Number each question clearly; questions may be answered in any order.
- Make sure that you read each question carefully before attempting to answer the question.
- Show all steps (and units) in calculations; this is a ‘closed book’ test.
- Ensure your responses are legible, clear and include relevant units (where appropriate).

QUESTION 1 **[20]**

1.1. Name and briefly explain three (3)classifications of minerals [6]
1.2. Distinguish between toughness and hardness of the material [4]
1.3. A copper tube with wall thickness of 8 mm must carry an axial tensile force of 175 kN. The allowable tensile stress is 90 MPa. Calculate the minimum required outer diameter is approximately. [10]

QUESTION 2 **[20]**

2.1. Discuss hydrogen degradation, its causes and how it can be prevented [8]
2.2. With the use of a diagram, describe how you would protect an underground cast iron from corrosion using cathodic protection for both galvanic and impressed current system. Which material will you use as a sacrificial anode and why? [12]

QUESTION 3 **[21]**

3.1. Explain the importance of pre-conditioning water prior water treatment. [4]
3.2. Describe screening process [3]
3.3. Distinguish between water treatment and waste water treatment [4]
3.4. Discuss the sources and causes of air pollution [4]
3.5. What are the negative effects of water pollution on humans, animals and plants [6]

QUESTION 4 **[20]**

4.1. Define comminution [2]
4.2. Describe the operation principles of attrition mills [6]
4.3. A crusher is used to grind sugar from crystals of which it is acceptable that 80% pass a 500-µm sieve, down to a size in which it is acceptable that 80% passes a 88 µm sieve, and a 5-horsepower motor is found just sufficient for the required throughput. If the requirements are changed such that the grinding is only down to 80% through a 125 µm sieve but the throughput is to be increased by 50% would the existing motor have sufficient power to operate the grinder? Assume that Bond's equation holds. [12]

QUESTION 5 **[19]**

5.1. Why is separation needed? [3]
5.2. Determine the advantages and disadvantages of mechanical separation [4]
5.3. Explain the working principle of both magnetic and electrostatic separation [12]

END OF EXAM **TOTAL MARKS = 100**

FULL MARKS= 100

FORMULA SHEET

STRENGTH OF MATERIALS

$$\sigma = E \cdot \varepsilon \qquad \sigma = \frac{F}{A}$$

PARTICLE SIZE REDUCTION

Kick's Law $\boldsymbol{E} = K_K \cdot f_c \cdot \log_e\left(\frac{L_1}{L_2}\right)$ *or* $\boldsymbol{E} = K_K \cdot f_c \cdot \ln\left(\frac{L_1}{L_2}\right)$

Rittinger's Law $\boldsymbol{E} = K_R \cdot f_c \cdot \left(\frac{1}{L_2} - \frac{1}{L_1}\right)$

Bond's Law $\boldsymbol{E} = E_i \cdot \left({}^{100}/_{L_2}\right)^{1/2} \cdot \left(1 - {}^{1}/_{q^{1/2}}\right)$ with $q = \frac{L_1}{L_2}$

Specific surface area $V_{\mathbf{P}} = p \cdot D_{\mathbf{P}}^3$ $A_{\mathbf{P}} = 6 \cdot q \cdot D_{\mathbf{P}}^2$ **Shape factor** $\lambda = \frac{q}{p}$

MATERIAL HANDLING

Tensions ratio for a flat conveyor belt $T_1 = T_2 e^{\mu\theta}$

Tensions ratio for a v-conveyor belt $T_1 = T_2 e^{\frac{\mu\theta}{\sin(\frac{\phi}{2})}}$

Effective belt tension $T_e = T_1 - T_2 = \frac{P_T}{v}$

Maximum belt tension $T_1 = T_e \frac{e^{\mu\theta}}{e^{\mu\theta} - 1} \Rightarrow T_1 = T_e \frac{e^{\mu\theta}}{e^{\mu\theta} - 1}$ with $n = e^{\mu\theta}$

Maximum permissible belt stress $\sigma = \frac{T_1}{W \cdot p}$

Power required at the driving drum $P_T = T_e v = (T_1 - T_2)v = T_1\left(1 - \frac{1}{e^{\mu\theta}}\right)v$ & $P_T = P_e + P_m \pm P_r$

Motor power $P = \frac{P_T}{\eta}$

Power required to drive the empty belt $P_e = F_e v = m_i(l + 45) g \mu_e v$

Power required to convey material $P_m = m_m g l \mu_m v$

Power required to raise material $P_r = (Cap)gh$

GALVANIC SERIES: The following is the galvanic series for stagnant (that is, low oxygen content) water. The order may change in different environments.

CATHODIC OR MOST NOBLE(PROTECTED END)
Graphite
Palladium
Platinum
Gold
Silver
Titanium
Stainless steel 316 (passive)
Stainless Steel 304 (passive)
Silicon bronze
Stainless Steel 316 (active)
Monel 400
Phosphor bronze
Admiralty brass
Cupronickel
Molybdenum
Red brass
Brass plating
Yellow brass
Naval brass 464
Uranium 8% Mo
Niobium 1% Zr
Tungsten
Stainless Steel 304 (active)
Tantalum
Chromium plating
Nickel (passive)
Copper
Nickel (active)
Cast iron
Steel
Lead
Tin
Indium
Aluminum
Uranium (pure)
Cadmium
Beryllium
Zinc plating (see galvanization)
Magnesium
ANODIC OR LEAST NOBLE (CORRODED END)