NATIONAL PROFESSIONAL EXAMINATIONS

NOVEMBER/DECEMBER 2011

09-MMP- A3 - Mineral Processing

DURATION : 3 hours

NOTES:

(1) This is a CLOSED BOOK EXAM. No notes or textbooks permitted.

(2) Candidates may use one of the approved Casio or Sharp calculators.

(3) Answer all questions except where otherwise noted, i.e. in Problem 7.

(4) Show all calculations.

(5) Page 6 is to be handed in with the examination booklet

(6) If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

(7) The mark distribution is as follows:

Problem 1 (a) 10 (b) 8 Total 18 marks

Problem 2 (a) 10 (b) 4 (c) 4 Total 18 marks

Problem 3 Total 4 marks

Problem 4 Graph 5 marks (a) 5 (b) 5 (c) 5 Total 20 marks

Problem 5 Total 5 marks

Problem 6 Total 5 marks

Problem 7 Six marks for each part Total 30 marks

Bonus Question 2 marks

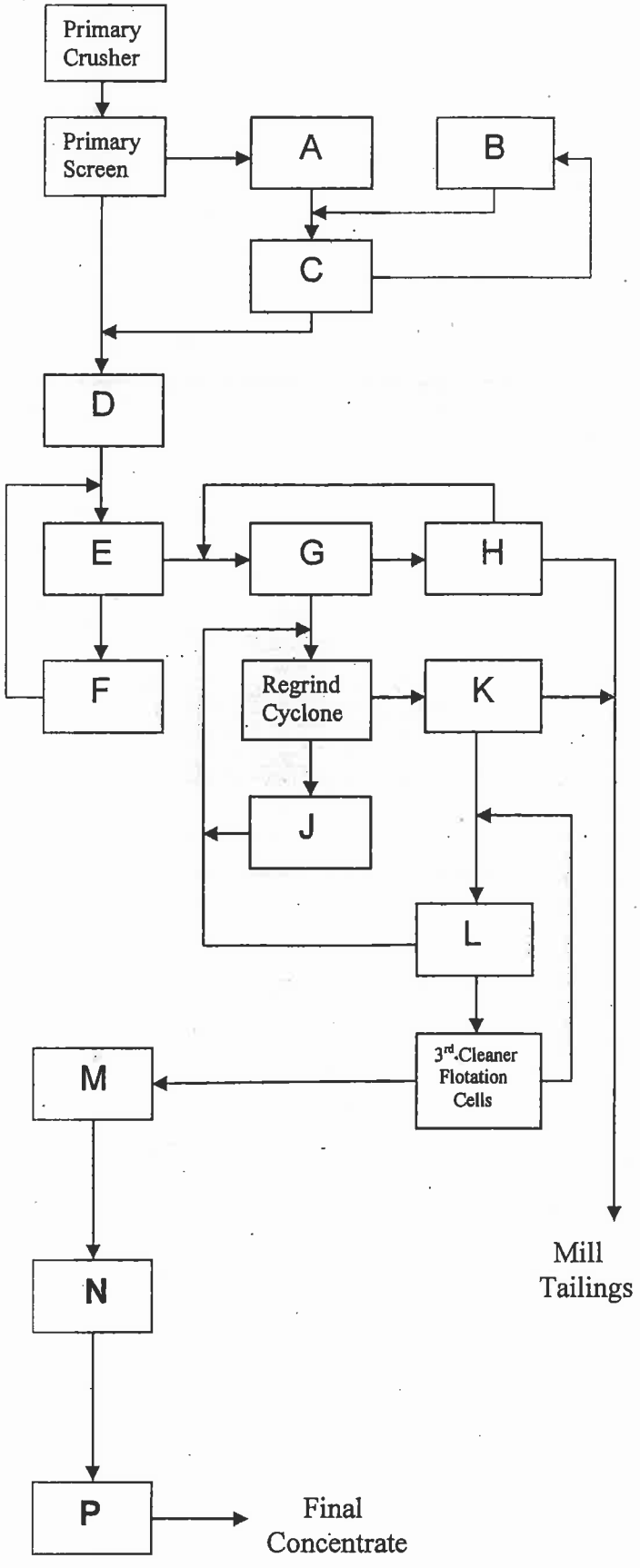
Unit conversions:

1 tonne = 1000kg = 2202.6 lb
1 ton = 2000 lb
1 inch = 2.54 cm = 25,400 microns (μm)

PROBLEM 1

(a) Shown to the right is the flowsheet of the Bell concentrator which operated in central British Columbia from 1972 to 1992. The mill processed 13,000 tpd of ore from an open pit mine to produce a copper concentrate. Identify the unit operations which best fit into the flowsheet at the appropriate locations from **A** to **P**. Select the unit operations from the list below: **(10 Marks)**

thickener
secondary screen
scavenger flotation cells
ball mill
1st stage cleaner flotation cells
tertiary crusher
hydrocyclones
regrind ball mill
dryer
rougher flotation cells
2nd stage cleaner flotation cells
filter
secondary crusher
rod mill



Problem 1 Continued

(b)If the copper content of the solid streams at the Bell concentrator were:

Mill feed 0.5% Cu
Tailings 0.05% Cu
Concentrate 30.0 % Cu

Calculate the tpd of copper concentrate produced. **(8 Marks)**

Problem 2.

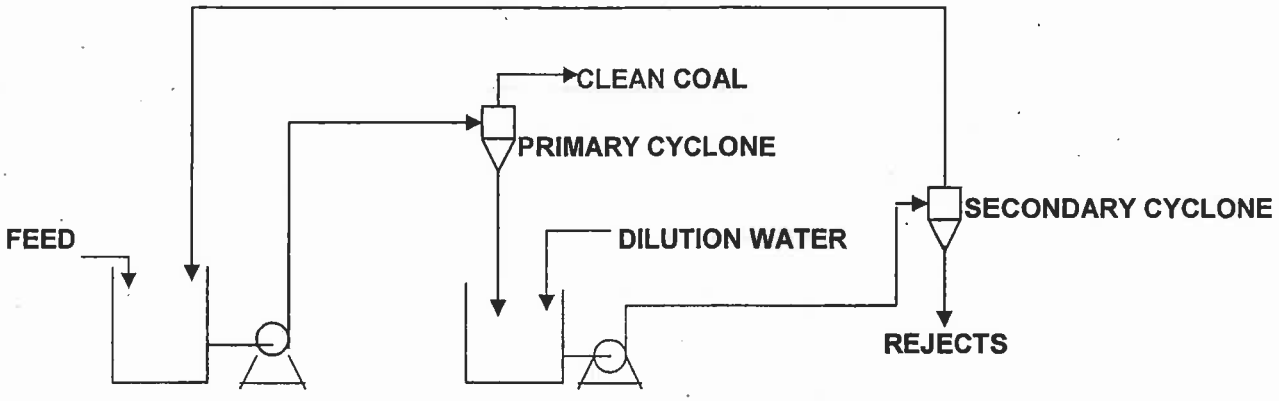


FIGURE 1. Layout of Coal Cleaning Circuit for Problem 2

A two-stage automedium (water only) cyclone circuit is used for cleaning 80 tonnes/hour of fine coal as illustrated in Figure 1. The circuit was sampled and the results were as follows:

	Percent Solids	Percent Ash
Circuit feed	12.5	25
Primary Cyclone Feed	13.16	25
Primary Cyclone Overflow (clean coal)	10.00	10
Primary Cyclone Underflow	25.00	47.5
Secondary Cyclone Overflow	16.67	25
Secondary Cyclone Underflow (rejects)	33.33	70

(a) Carry out a material balance and calculate the tonnes/hour of clean coal produced by the circuit. **(10 marks)**

(b) Calculate the tonnes/hour of dilution water added to the sump. **(4 marks)**

(c) Calculate the tonnes/hour of solids in the primary cyclone underflow. **(4 marks)**

Problem 3. (4 marks).
A flotation kinetics test was carried out on an oil sands sample. The results were as follows.

Flotation Time Minutes	Bitumen Recovery
1	60%
12	90%
15	90%

Assuming that the flotation follows the following first order rate equation:

$$R = Rl\,[1 - \exp(-kt)]$$

(a) Using the available data determine the parameters Rl and k. **(2 marks)**
(b) Determine the flotation time required to achieve an 80% recovery. **(2 marks)**

Problem 4.
Given that a sieve analysis was carried out on the flotation feed in the Bell concentrator described in Problem 1 with the results as follows:

Size Microns	Weight g
+425	17
-425+300	31
-300+212	24
-212+150	19
-150+106	15
-106+75	12
-75	42

Using the log-log graph paper provided on page six, plot the Cumulative Weight Percent Passing verses the Particle Size in microns **(5 marks)**. From the plot determine:

(a) the mass median size (50% passing size) in microns. **(5 marks)**

(b) the estimated percentage of material in the –75+37 micron fraction. **(5 marks)**

(c) using Bond's equation calculate the net power (kilowatts) required for comminution of the Bell copper ore. Assume a work index of 12, a relatively large feed size and a 24 hour day. **(5 marks)**

Bond's Equation:

$$W = \frac{10W_i}{\sqrt{P}} - \frac{10W_i}{\sqrt{F}}$$

Problem 5. (5 marks)

Using the information from Problems 1 and 4,calculate, using the Gy equation, the required size of sample of the Bell flotation feed required to obtain a copper assay that is accurate to within 0.01 % Cu, 95 times out of 100. Assume a value of C of 8.0 g/cm^3.

Gy Equation:

$$M = \frac{C\,d^3}{s^2}$$

6. Flotation collectors may be classified into four general categories:
   A. Dithiols (e.g. xanthates, aerofloats)
   B. Cationic (e.g. alkyl amines)
   C. Fatty acids & soaps (e.g. oleic acid, sulphonates)
   D. Non-polar (e.g. kerosene, fuel oil)

   For the following minerals indicate which type of collector (A, B, C, or D) would most likely be used to float that mineral.

   Galena (PbS)
   Sylvite (potash) (KCl)
   Molybdenite (MoS_2)
   Quartz (SiO_2)
   Bituminous coal
   Barite ($BaSO_4$)

(5 marks)

7. Describe, giving application examples, of the following topics as they relate to mineral processing. Provide sketches where applicable. ANSWER ANY **FIVE** OF THE FOLLOWING TEN TOPICS: **(6 marks each)**

   Flocculation
   Dense (Heavy) Medium Separation
   Classification
   Economic Efficiency
   Flotation column
   A size analysis method other than sieving
   High tension (electrostatic) separation
   Liberation
   Spiral (Humphreys)
   Frothers

(30 marks)

Bonus Question (2 marks):

List two mineral commodities produced in Canada which are not beneficiated using froth flotation.

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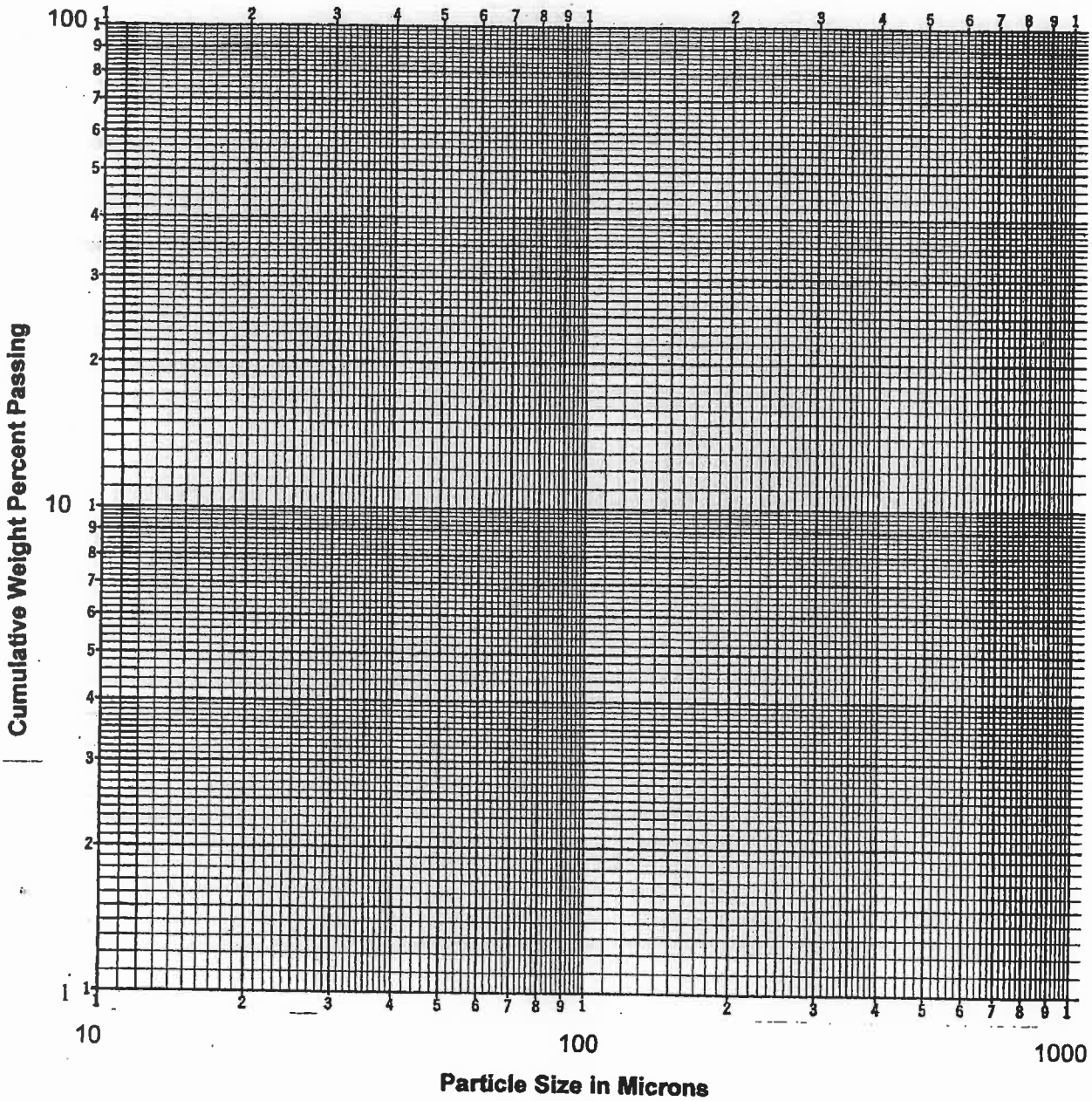

Figure 2. Size Analysis Graph for Problem 4

Marking Scheme

Problem 1 (a) 10 (b) 8 Total 18 marks

Problem 2 (a) 10 (b) 4 (c) 4 Total 18 marks

Problem 3 (a) 2 (b) 2 Total 4 marks

Problem 4 Graph 5 marks (a) 5 (b) 5 (c) 5 Total 20 marks

Problem 5 Total 5 marks

Problem 6 Total 5 marks

Problem 7 Five marks for each part Total 30 marks

Bonus Question 2 marks