NATIONAL PROFESSIONAL EXAMINATIONS

DECEMBER 2008

98-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 2.

(4) Show all calculations.

(5) 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.

(6) Hand in page six (plot for problem 4) with your examination booklet.

(7) The mark distribution is as follows:

Problem 1 Total 15 marks

Problem 2 Five Marks for each part, Total 30 marks

Problem 3 25 marks

Problem 4 8 marks

Problem 5 7 marks

Problem 6 15 marks

Problem 1. (15 marks)

The following is an excerpt from *Canadian Milling Practice* which describes the grinding circuit of the Key Lake uranium mill in northern Saskatchewan.

> **Grinding**
>
> The grinding circuit consists of a 4.42 diam. by 2.0 m long SAG mill in open circuit with a single sizing screen. Screen oversize reports to a 2.7 m diam. by 3.0 m long ball mill. The ball mill operates in closed circuit with two sizing screens. The undersize from all three screens reports to the neutral thickener. The thickened slurry is pumped at a nominal density of 50% solids to four air-agitated storage pachucas in leaching. The average feed rate is 65 t per operating hour. The product size is about 80% passing 300 μm and 45% passing 75μm. The work index of the ore is 23.7 kw-hr/t.

(a) Sketch a flow sheet of the Key Lake grinding circuit.

(b) If electrical power is available a 20¢/ Kw-hr, using Bond's equation estimate the power cost (in $/24-hr day) required for comminution of the ore. List the assumptions made in your calculation.

Bond's Equation:

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

(c) Using a grinding ball size of 0.1 m, calculate the percent critical speed If the SAG mill rotates at 13 rpm.

$$\text{Critical speed} \qquad N_c = \frac{42.3}{(D-d)^{0.5}} \quad \text{rev/min}$$

Problem 2. (30 marks).

Explain the similarities and differences between the following terms as they are applied to mineral processing. Use sketches in your answers. Answer **any SIX** of the following nine topics.

Coagulation/flocculation

Jig/table

Cateracting/cascading

Merrill-Crowe/carbon-in-pulp process

Magnetic/High tension separator

Mechanical/column flotation

d_{50}/d_{50c}

Bulk/reverse flotation

Gyratory/cone crusher

Problem 3. (25 marks)
A copper flotation circuit is used to concentrate 100 tonnes per hour of ore (valuable mineral is chalcopyrite (specific gravity 4.2, containing 34.6 % copper) with a siliceous gangue (specific gravity 2.6). The circuit layout is shown on the sketch below:

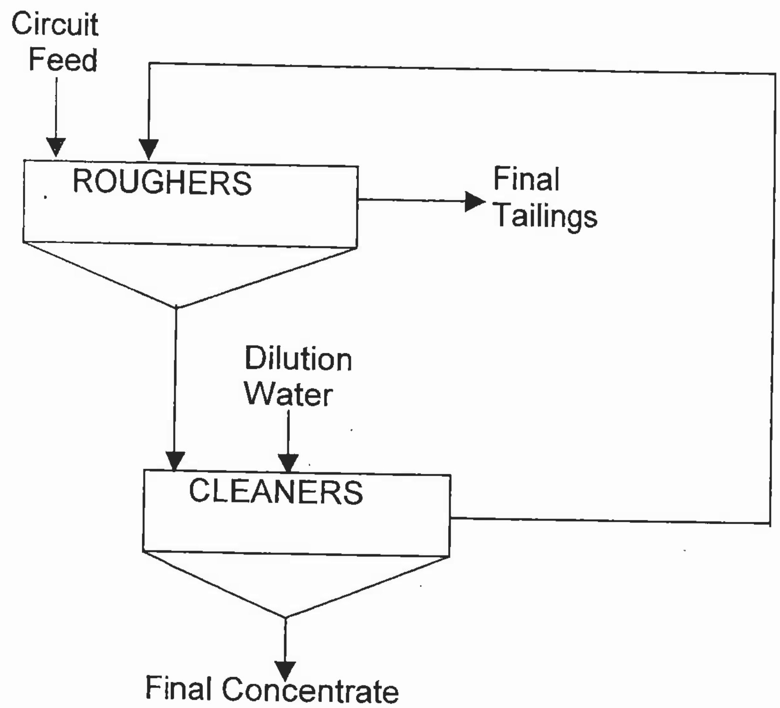

FIGURE 1. Layout of Flotation Circuit for Problem 2

Assume that the circuit was sampled and the results were as follows:

Stream	%solids by wt	% Cu
Circuit Feed	33.3	0.5
Rougher concentrate	50	13.89
Final Concentrate	75	25
Cleaner Tailings	33.3	5
Final Tailings	75	0.1016

Using the above data carry out a material balance and calculate the following:_
(a) the copper recovery in (i) the circuit
(ii) the cleaners
(iii) the roughers
(b) the tonnes/hour of dilution water added to the cleaners
(c) the tonnes/hour of final concentrate produced
(d) the tonnes/hour of solids recirculated back to the roughers i.e. the cleaner tailings.
(e) the specific gravity of the final concentrate solids

Problem 4 (8 Marks)

A sieve analysis was carried out on an ore. The results were as follows:

Size Fraction	Weight Grams
+ 600 µm	42.2
-600 + 300 µm	40.0
-300 + 150 µm	26.4
-150 + 75 µm	17.4
- 75 µm	33.9

Using the log-log graph paper provided on page 6, plot the Cumulative Weight Percent Passing versus the Particle Size in microns. From the plot determine:

(a) the 80 % passing size in microns

(b) the estimated percentage of material in the –75+37 micron fraction

Problem 5. (7 marks).

$$V = \frac{g\ d^2\ (D_s - D_f)}{18\ \mu}$$

(a) Using Stokes' equation (given above) calculate the diameter of a coal particle (Specific gravity 1.4) which would settle in water at the same rate as a 40-micron diameter quartz (Specific gravity 2.65) particle settling in water.

(b) Repeat the calculation in part (a) for both particles settling in air.

Problem 6. Short answer questions **15 marks**

(a) Given the following flotation reagents, classify them according to their function, and for each, give an example of an application:

potassium amyl xanthate
sodium cyanide
methyl isobutyl carbinol
copper sulphate

(b) Why is the heap leaching of gold usually more economical than leaching in stirred tanks?

(c) The rate of flotation is usually described by the following equation:

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

where R is the cumulative recovery of a given mineral species in time t

Define the meanings of k and RI

(d) Referring to problem 3, assuming you wish to collect samples for copper assays of the final concentrate and final tailings from the circuit. Which should be the larger sample and why?

(e) Referring to Problem 3, if the circuit were operated without the cleaners, would the overall copper recovery increase, decrease or not change?

Bonus Question (2 marks):

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

HAND IN THIS PAGE WITH YOUR EXAMINATION BOOKLET

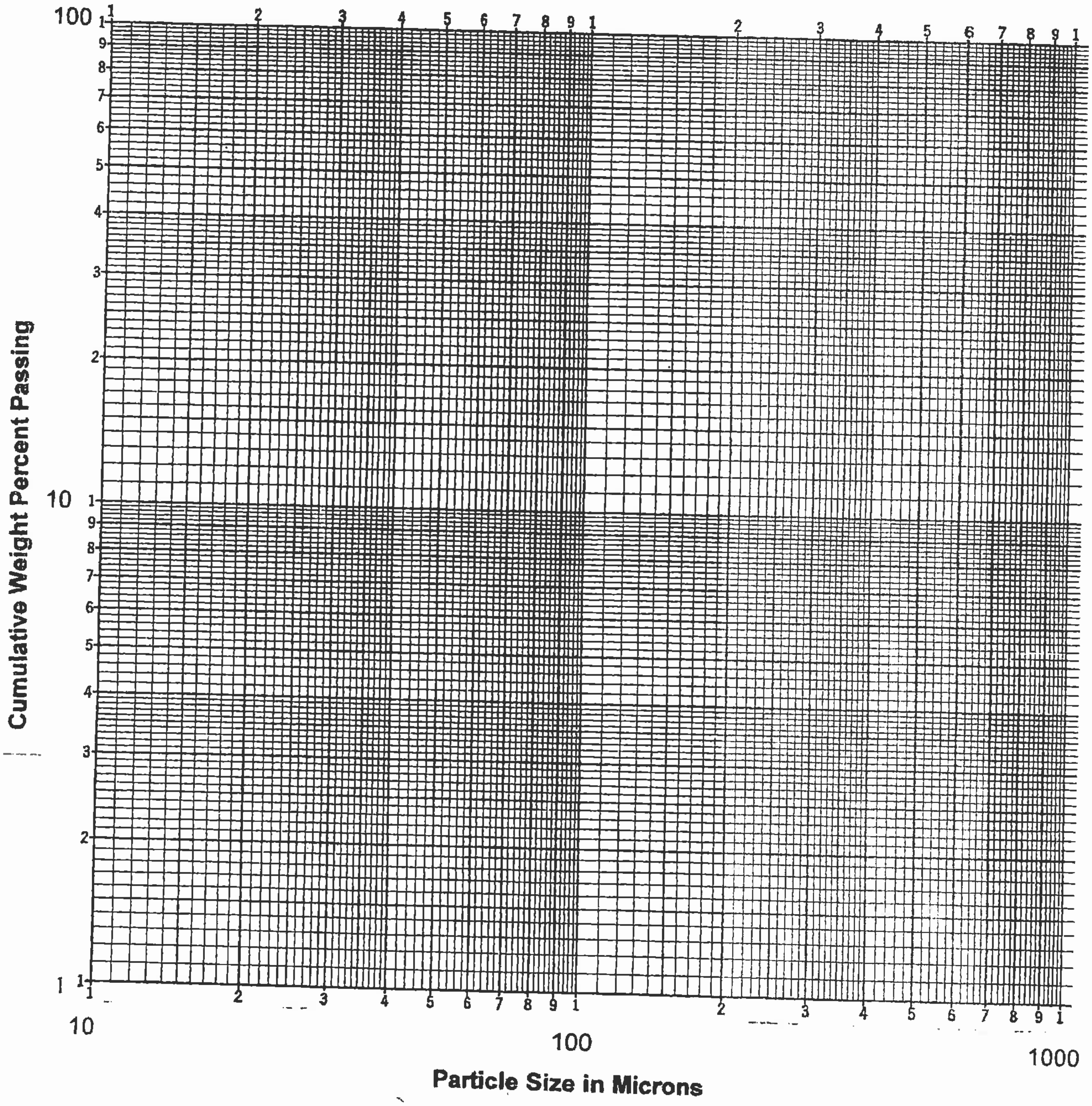

Figure 2. Size Analysis Graph for Problem 4