National Exams May 2019

10-Met-B1, Mineral Processing

3 hours duration

NOTES:

1. 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.
2. This is a CLOSED BOOK EXAM.
3. Approved Casio or Sharp calculator is permitted.
4. Four (4) questions constitute a complete exam paper.
5. Hand in Page 2 and Page 3 together with the examination booklet.
6. Marking scheme:

Question 1.	15 marks.
Question 2.	(1) 5; (2) 15. Total 20 marks.
Question 3.	(1) 15; (2) 10. Total 25 marks.
Question 4.	5 marks each. Total 40 marks.
Grand Total	100 marks

QUESTION 1

The Buick Concentrator at Boss, Montana, treats a Pb-Zn ore and produces a Pb concentrate, a Zn concentrate and a final tailing. The following shows part of the metallurgical balance of the Concentrator. Complete the metallurgical balance table by filling in the missing nubers. **(15 marks)**

Product	**Weight, %**	**Assay, %**		**Distribution, %**	
		Pb	Zn	Pb	Zn
Feed	100.0	5.05	2.26		
Pb Concentrate	6.2	76.33	3.03		
Zn Concentrate	3.3	1.76	55.45		
Final tailing					

QUESTION 2

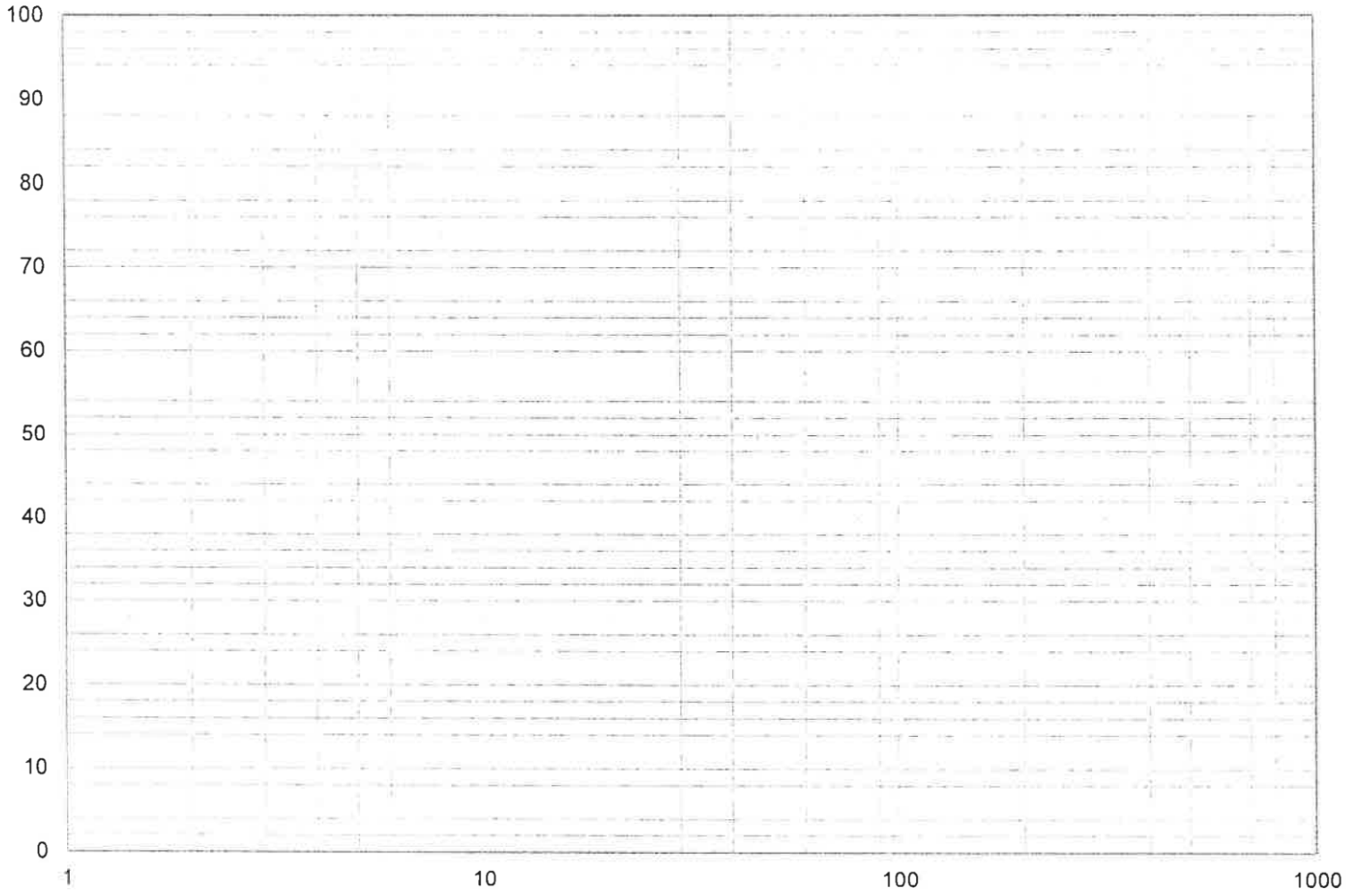
A 600 t/h crushing plant incorporates a closed circuit crushing stage using a cone crusher. The circuit is closed with an inclined vibrating screen. The circulation load is 150%.

(1) Sketch the flowsheet, indicating tonnage rates (t/h) for each stream. **(5 marks)**

(2) Using those tonnage rates and the size analyses of the screen products given below, plot the partition curve. From the plotted partition curve, determine the cut size d_{50} of the screening operation. **(15 marks)**

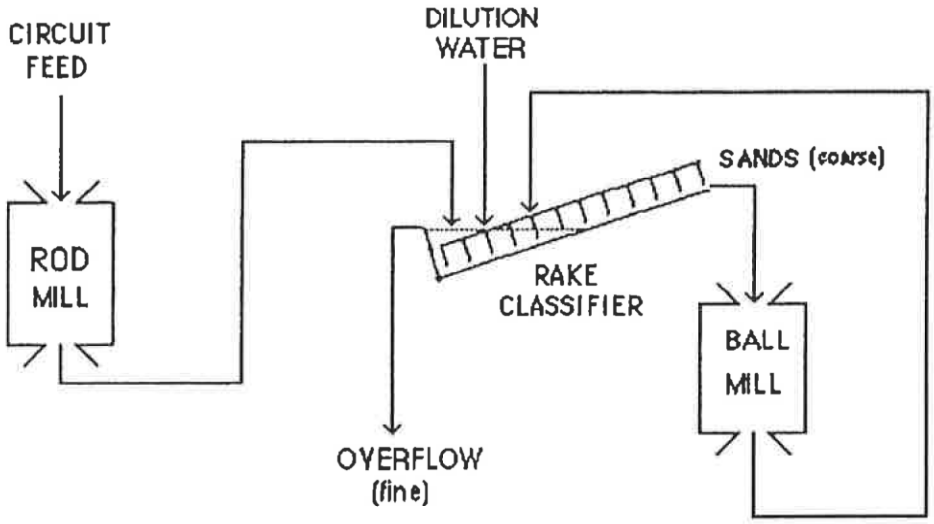
Size	wt % Retained		Product flowrate, t/h		% Reporting
mm	Oversize Product	Undersize Product	Oversize	Undersize	to Oversize
32	45.8	0.7			
16	47.5	7.0			
8	5.3	48.2			
4	0.6	25.6			
2	0.3	10.7			
-2	0.5	7.8			
Total	100.0	100.0			

A graph paper can be found on the next page.


100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000

QUESTION 3

A two-stage grinding circuit using a rod mill in open circuit and a ball mill in closed circuit with a rake classifier is used to grind 50 tonnes per hour of ore (specific gravity = 3.0 and Bond Word Index = 13.5 kWh/t). The circuit layout is illustrated in the following figure:



At steady state the circuit is sampled and the results are as follows:

Stream	% solids by weight	wt % passing 100 μm
Circuit feed	80	5
Rod mill discharge	80	20
Classifier sands (ball mill feed)	75	20
Classifier overflow	33.3	75
Ball mill discharge	75	47.5

(1) Using the above data, carry out a material balance and calculate the following: **(15 marks)**

(i) The tonnes/hour dilution water added to the rake classifier.
(ii) The tonnes/hour solids ground in the ball mill.

(2) Assume that the particle size of solids in each stream follow the Gates-Gaudin-Schumann distribution with a distribution modulus of 0.6 (i.e., the slope of the straight line on the log-log plot is 0.6), what would be the approximate power rating (kW) of the rod mill? Bond equation is $W = 10W_i\left[\frac{1}{\sqrt{P}} - \frac{1}{\sqrt{F}}\right]$. List any other assumptions. **(10 marks)**

QUESTION 4

Answer eight (8) of the following 10 questions: **(5 marks each)**

(1) In a fire assay, the final gold bead weighs 0.5 mg, what is the gold grade of the ore (g/t)? (In fire assay, one assay-ton is 29.17 g).

(2) In a standard Bond Grindability test on a -6 mesh ore sample with an 80% passing size of 2350 μm, when the circuit reached steady state with 250% circulation load, one revolution of the ball mill rotation generated 1.6 grams (net) of -105 μm material with an 80% passing size of 89 μm. What is the Bond Work Index of the ore?

$$W_i = \frac{44.5}{P_1^{0.23} G^{0.82} \left[\frac{10}{\sqrt{P_{80}}} - \frac{10}{\sqrt{F_{80}}} \right]}.$$

(3) A copper ore processing plant treats a copper ore which contains 1.2% Cu. It produces a copper concentrate that contains 32% Cu and recovers 95% of the copper from the ore. What is the grade of Cu in the plant tailings?

(4) If the radius of a tumbling ball mill is 2.6 m, what is the maximum allowable rotating speed of the mill for it to operate properly?

(5) The specific gravity of chalcopyrite ($CuFeS_2$) and pyrite (FeS_2) is 4.3 and 5.0, respectively. Can these two minerals be separated by gravity separation in water?

(6) A 670 mL slurry sample is taken from a hydrocyclone underflow and it weighs 830 grams. If the specific gravity of the solids is 3.0, what is the concentration of the solids (wt% solids) in the hydrocyclone underflow?

(7) A flotation test on a 4 kg Pb-Zn ore sample is to be carried out at 40 wt% solids using 50 grams/tonne xanthate as a collector. The xanthate has been prepared as a 5 wt% solution. How many milliliters of the xanthate solution should be added to the flotation cell? What is the concentration of the xanthate in the liquid phase (mg/kg)?

(8) Explain why quartz is naturally hydrophilic, while graphite is naturally hydrophobic.

(9) In the equation $E_p = \frac{d_{75} - d_{25}}{2}$, what is E_p known as and what does it measure?

(10) Through BET surface area measurement, it is found that the specific surface area of a powder sample is 1.4 m^2/g and the density of the powder solids is 2.6 g/cm^3. What is the specific surface diameter (d_{SV}) of the sample?