National Exams December 2018

09-MMP-A3, 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. No notes or textbooks permitted.

3. Approved Casio or Sharp calculator is permitted.

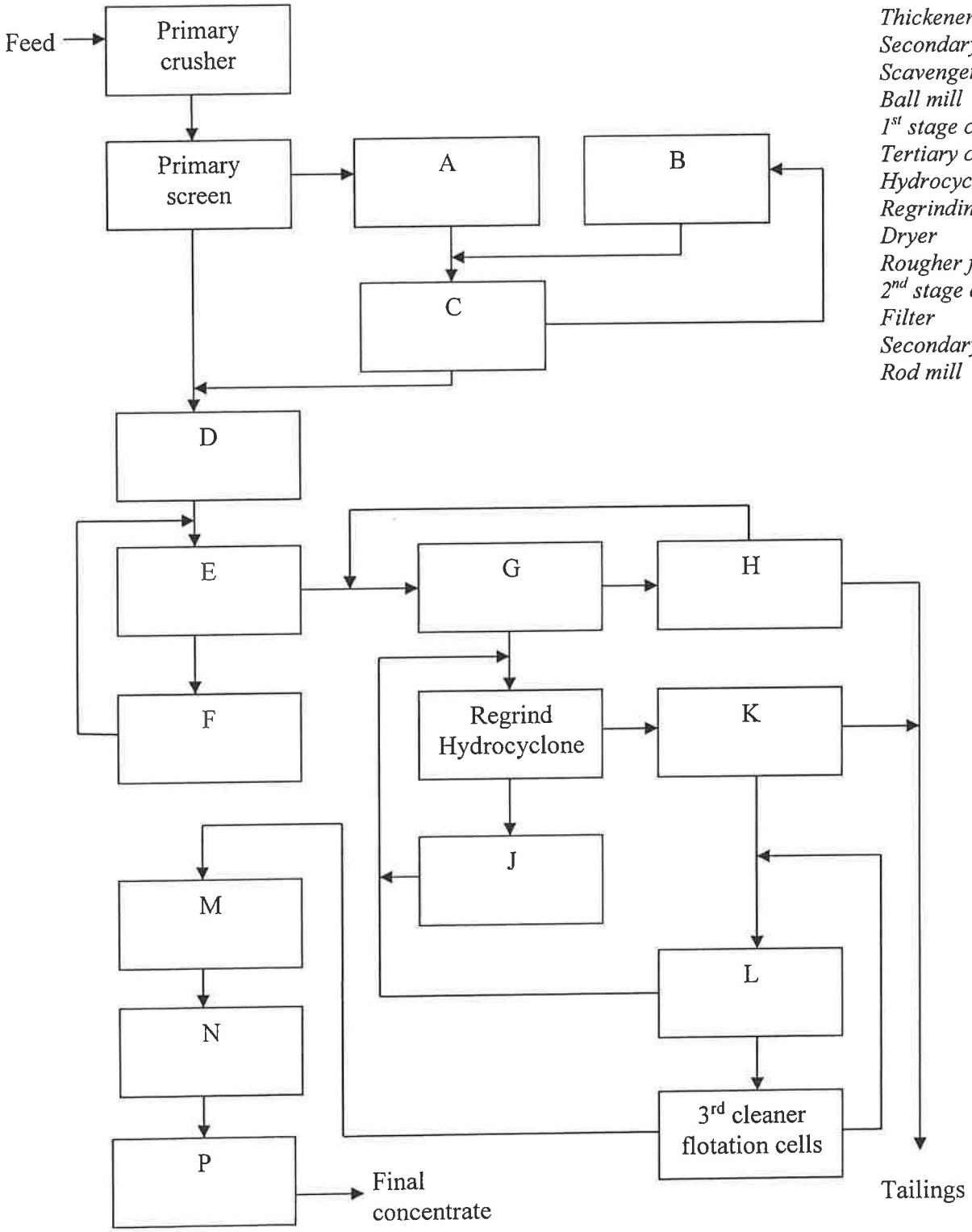
4. FOUR (4) questions constitute a complete exam paper.

5. Marking scheme:

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

Question 1

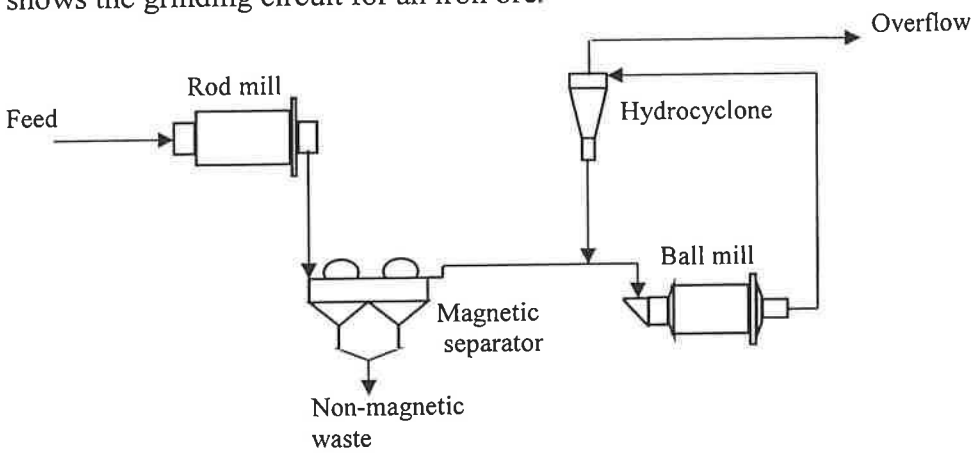
The following figure shows the flowsheet of the Bell Concentrator which operated in central British Columbia from 1972 to 1992. The mill processed 13000 tonnes per day of ore from an open pit mine to produce a copper concentrate. Identify the unit operations (select from the list below) which best fit into the flowsheet at the appropriate locations from A to P, and write the names of the unit operations in the letter boxes. **(15 marks)**



Thickener
Secondary screen
Scavenger flotation cells
Ball mill
1st stage cleaner flotation cells
Tertiary crusher
Hydrocyclone
Regrinding ball mill
Dryer
Rougher flotation cells
2nd stage cleaner flotation cells
Filter
Secondary crusher
Rod mill

Question 2

The following shows the grinding circuit for an iron ore.



After grinding in a rod mill, the ore is sent to a magnetic separator to remove the non-magnetic wastes before being fed to the ball mill. The following operating data are available:

- Rod mill:
  - Feed rate: 100 t/h iron ore;
  - Feed ore grade: 35% Fe;
  - Rod mill discharge: 80% passing 2500 μm;

- Magnetic separator:
  - Grade of non-magnetic waste: 5% Fe;

- Ball mill:
  - Recirculation load: 250%;
  - Product size required: 80% passing 150 μm;
  - Bond work index: 11.5 kWh/t

- Hydrocyclone:
  - Grade of overflow solids: 45% Fe.

(1) Calculate the ball mill power rating in kW. **(15 marks)**
(2) Calculate the flowrate of the ore (t/h) through the ball mill. **(5 marks)**

Clearly state any assumptions.

Question 3

Answer 8 of the following 12 questions. Use sketches to aid your answers for questions 6 to 12. **(5 marks each)**

1) A hydrocyclone underflow slurry contains 70 wt% solids. If the specific gravity of the solids is 2.6, what is the density of the underflow slurry in unit of kg/m^3?

2) A flotation test on a 2 kg Cu-Zn ore sample is to be carried out using 20 g/t potassium ethyl xanthate. The potassium ethyl xanthate has been prepared as a 1.0 wt% solution. How many grams of the xanthate solution should be added to the flotation cell?

3) The specific gravity of pyrite and chalcopyrite is 5.0 and 4.3, respectively. Can these two minerals be separated by gravity separation? (Hint: Calculate the gravity separation criterion)

4) An ore contains 3.5 wt% galena (PbS) and 150 g/t Ag. The Ag is distributed in the galena matrix. If the galena can be 100% recovered as a pure PbS concentrate (theoretical galena concentrate), what will be the grade (g/t) of Ag in the galena concentrate?

5) The particle sizes of a powdered material follow the Gaudin-Schumann distribution. The Distribution Modulus is 0.56 and the Size Modulus is 220 μm. Calculate the percentages of the materials in the particle size range of –150+74 μm.

6) Describe how copper ions activate the flotation of ZnS when isopropyl xanthate is used as a collector at pH 9.

7) Explain d_{50} and d_{50c} associated with hydrocyclone operations.

8) Describe how a flotation column works.

9) Describe the concept of acid mine drainage (AMD). How to determine the AMD potential of a mine tailings?

10) Describe how a polymer flocculant helps improve the settling rate of mineral slurry in a thickener.

11) Why does the length/diameter ratio of a rod mill need to be larger than 1.25? Why does the length/diameter ratio of a SAG mill need to be much less than 1?

12) Describe how a "carrier flotation" process works.

Question 4

In an audit of a niobium oxide flotation plant in eastern Canada, the rougher flotation feed, concentrate and tail were sampled and screened. The screened size fractions were assayed for Nb_2O_5, and the results are shown in the following table:

Product	Size, μm	Weight, %	Assay of Nb_2O_5, %
Rougher Feed	+208	22.1	0.52
	-208+147	21.4	0.65
	-147+104	21.2	0.78
	-104+74	12.0	0.85
	-74+37	12.9	1.14
	-37	10.4	1.46
	Total	100.0	
Rougher Concentrate	+208	8.6	4.09
	-208+147	10.8	4.98
	-147+104	14.4	4.68
	-104+74	11.0	4.00
	-74+37	23.0	2.86
	-37	32.2	2.12
	Total	100.0	
Rougher Tail	+208	25.9	0.19
	-208+147	24.4	0.12
	-147+104	23.1	0.10
	-104+74	12.2	0.05
	-74+37	10.1	0.04
	-37	4.3	0.07
	Total	100.0	

Answer the following questions: **(5 marks each)**

(1) What is the enrichment ratio of Nb_2O_5 in the +208 μm size fraction? What is the enrichment ratio of Nb_2O_5 in the -37 size fraction?

(2) What conclusions can you draw from the enrichment ratio results in (1)?

(3) What is the recovery of Nb_2O_5 in this rougher flotation?

(4) What is the recovery of Nb_2O_5 in the +208 μm size fraction? What is its recovery in the -37 μm size fraction?

(5) What conclusions can you draw from the recovery results in (4)?