National Exams May 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. SIX (6) questions constitute a complete exam paper.

5. Hand in Page 4 of this exam together with your exam answer booklets.

6. Marking scheme:

Question 1.	(a) 3 (b) 3 (c) 3 (d) 3 (e) 6 (f) 6. Total 24 marks.
Question 2.	6 marks.
Question 3.	12 marks.
Question 4.	5 marks each. Total 30 marks.
Question 5.	(a) 2 (b) 2 (c) 8 (d) 3 (e) 5. Total 20 marks.
Question 6.	2 marks each. Total 8 marks.
Grand Total	100 marks

QUESTION 1

The mineral processing plant of Highland Valley Copper Mine treats a copper ore and produces a copper concentrate and a final tailings. The main value mineral is bornite (Cu_5FeS_4). Typical assays of the feed, concentrate and tailings of the plant are 0.388%, 41.4% and 0.033% Cu, respectively. Calculate:

(1) The Enrichment Ratio. **(3 marks)**
(2) The Concentration Ratio. **(3 marks)**
(3) The weight % of Cu concentrate produced. **(3 marks)**
(4) The copper recovery into the concentrate. **(3 marks)**
(5) The content of bornite in the copper concentrate (The atomic masses of Cu, Fe and S are 63.5, 55.8 and 32.0 g/mol, respectively). **(6 marks)**
(6) The separation efficiency of the plant. **(6 marks)**

QUESTION 2

Solutions of tetrabromoethane (TBE) mixed with carbon tetrachloride are used as heavy liquid in laboratory gravity separation tests. At 25°C, the density of TBE is 2.96 g/cm^3 and the density of carbon tetrachloride is 1.58 g/cm^3. To prepare a heavy liquid with a density of 2.00 g/cm^3, what should be the concentration (wt%) of TBE in carbon tetrachloride? **(6 marks)**

QUESTION 3

The froth treatment tailings from Alberta oil sands operation are known to contain the following minerals. Draw a process flowsheet that could produce a zircon concentrate. The minerals in the tailings are mostly liberated and the tailings are in the wet slurry form. In the flowsheet, show major process steps in block diagrams and the minerals that are rejected at each step. **(12 marks)**

Mineral	Chemical Formula	Specific gravity	Magnetic property	Electrical conductivity
Rutile	TiO_2	4.2	Non-magnetic	Conductor
Pyrite	FeS_2	4.9	Non-magnetic	Conductor
Zircon	$ZrO_2.SiO_2$	4.7	Non-magnetic	Non-conductor
Ilmenite	$TiO_2.FeO$	4.5	Magnetic	Conductor
Magnetite	Fe_3O_4	5.5	Highly magnetic	Conductor
Siderite	$FeCO_3$	3.8	Magnetic	Non-conductor
Garnet	$(Ca,Mg,Fe)_3(Al,Fe)_2(SiO_4)_3$	3.4	Magnetic	Non-conductor
Monazite	$(Ce,La,Y,Th)PO_4$	4.9	Magnetic	Non-conductor
Staurolite	$Fe_2Al_9O_6(SiO_4)_4(O,OH)_2$	3.7	Magnetic	Non-conductor
Tourmaline	A silicate mineral	3.0	Weakly magnetic	Non-conductor
Mica	A mineral group	2.8	Non-magnetic	Non-conductor
Quartz	SiO_2	2.6	Non-magnetic	Non-conductor

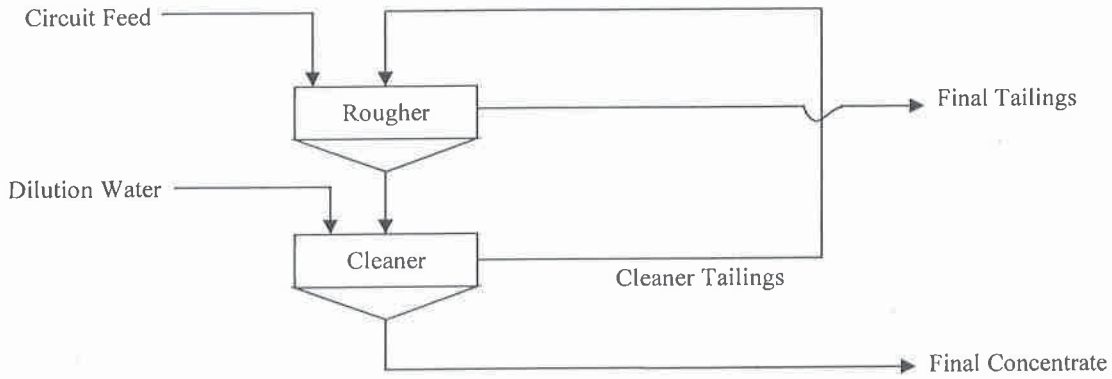
QUESTION 4

Explain the similarities and differences between the following pairs of terms as they are related to mineral processing. Use sketches in your answers. Answer any six (6). **(5 marks each)**

1) Coagulation / Flocculation
2) Jig / Shaking Table
3) Mechanical Flotation Cell / Column Flotation Cell
4) Frother / Collector
5) Gyratory Crusher / Cone Crusher
6) Dense Medium Cyclone / Classification Cyclone (or Water-Only Cyclone)
7) Upstream Tailings Dam / Downstream Tailings Dam
8) Magnetic Separator / High-Tension Separator
9) d_{50} / d_{50C}
10) SAG Mill / Ball Mill

QUESTION 5

A copper flotation circuit is used to concentrate 100 tonnes per hour of ore (value mineral is chalcopyrite) with a silica gangue. The circuit layout is shown on the sketch below:



After reaching steady state, the circuit was sampled and the results were as follows:

Stream	% solids by weight	% Cu
Circuit Feed	33.3	0.5
Rougher Concentrate	50.0	13.9
Final Concentrate	40.0	25.0
Cleaner Tailings	8.6	5.0
Final Tailings	31.1	0.1

Using the above data, calculate the following:

(1) The copper recovery in the circuit. **(2 marks)**
(2) The copper recovery in the Cleaner. **(2 marks)**

(3) The tonnes/hour of solids circulated back to the Rougher (i.e., the Cleaner Tailings). **(8 marks)**
(4) The copper recovery in the Rougher. **(3 marks)**
(5) The tonnes/hour of dilution water added to the Cleaner. **(5 marks)**

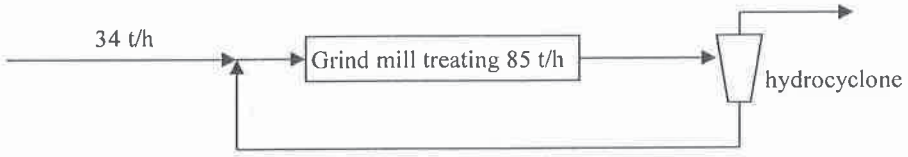
QUESTION 6

Fill in the blanks: **(2 marks each)**

(1) The typical cutoff size between sieve and sub-sieve size analyses is _____ μm.

(2) The current copper price is US$6.83/kg. If the average grade of a copper sulfide deposit is 1.2% Cu with no other value metal, the contained value of the deposit is _____ US$/t.

(3) When the following circuit runs at steady state, the circulation load is _____%.



(4) The solid in the following figure is _____ and most likely cannot be floated.