UNIVERSITY OF TORONTO

ŧ.

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 2001

Third Year - Program AELMEBASC

MMS 301S - Mineral Processing

Examination Type B

Examiner - G. E. Agar

ANSWER ALL QUESTIONS

Four pieces of graph paper, one linear, two semi logarithmic and one log-log are supplied. A graph of C_D versus N_R is also included.

Marks

1) A spherical particle 0.05 cm diameter settles freely in water. Calculate the terminal free settling velocity.

Specific gravity of quartz = 2.65 Specific gravity of water = 1.0 $g = 980 \text{ cm/sec}^2$ Viscosity of water (μ) = 0.01 g/cm-sec

$$R = C_D * A * v^2 * \rho_1 / 2$$

 $N_R = v * d * \rho_1 / \mu$

2) In the following table the assays of feed and products from an operating concentrator are given. Calculate the best fit material balance from this data and the distribution of elements into the products.

	Assays (%)										
	Cu	Pb	Zn								
Feed	2.65	0.15	3.71								
Cu Conc	27.55	0.66	2.68								
Zn Conc	0.54	0.46	53.66								
Tails	0.12	-0.07	0.54								

- 3) The flowsheet for a concentrator is as follows: a rougher followed by a scavenger on the rougher tails. The scavenger tails are the final tails. The scavenger concentrate joins the feed to the rougher stage. The rougher concentrate is subjected to three cleaning stages operated counter currently. The 1st cleaner tails become part of the rougher feed. Prepare a connection matrix to describe this circuit and calculate the minimum number of streams that must be sampled in order to calculate a complete material balance.
- 4) Batch laboratory grinding tests were done on charges of a single size fraction of ore. The tests were done for specifies time periods then the charge was screened. The following data was collected.

Time(sec)	0	30	60	90	120
Size (mm)		Weight f	raction retain	ed	
+1.2	1	0.56	0.31	0.17	0.10
1.2/0.84		0.12	0.16	0.15	0.12
0.84/0.6		0.06	0.08	0.09	0.08
0.6/0.42		0.05	0.08	0.09	0.10
0.42/0.3		0.04	0.07	0.08	0.09
-0.3		0.17	0.30	0.42	0.51

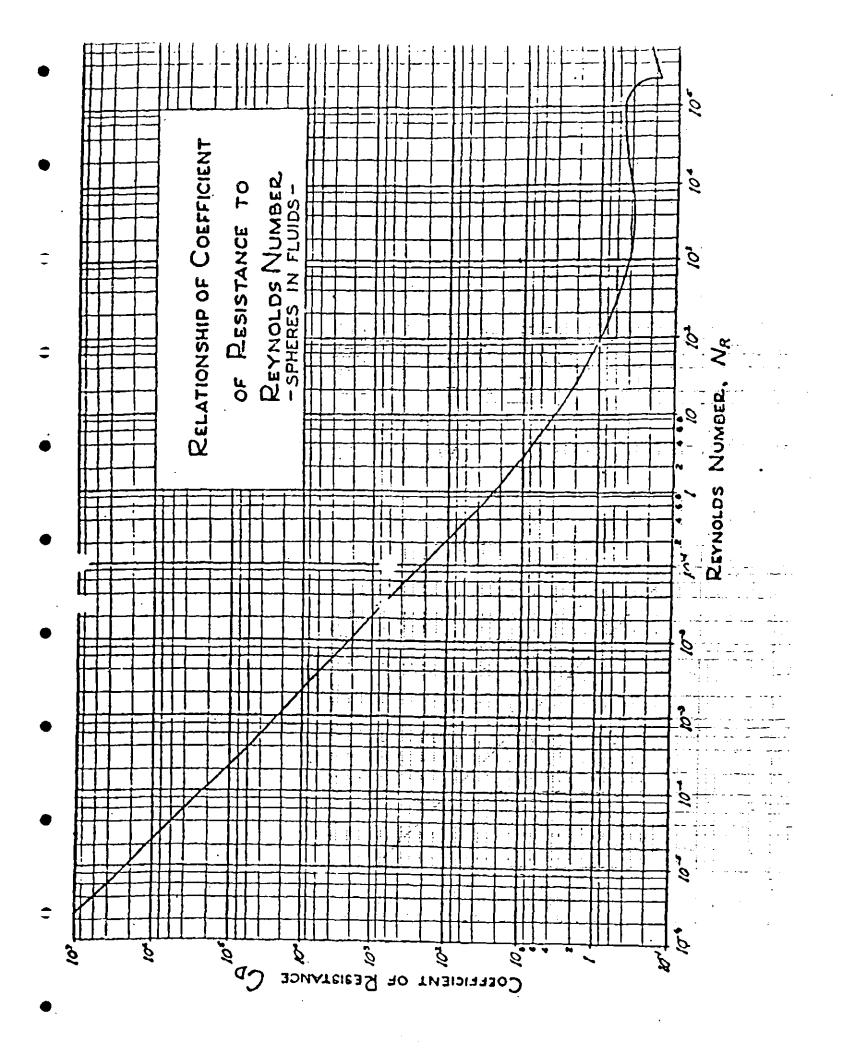
Calculate the first order rate constant for the disappearance of the two coarsest by two different methods.

5) A batch flotation test was done in order to collect rate data for the separation of two minerals. The data is given below. Fit this data to an equation of the form R = R1 (1 - exp(-k(t + φ)))

Time(sec)	Sp	Py :
0	0	0
15	0.2027	0.0249
30	0.3622	0.0474
60	0.5863	0.0857
120	0.8107	0.1421
180	0.8967	0.1791
300.	0.9422	0.2194
480	0.9496	0.2413

6) Batch flotation tests are often done during the development of a separation process for new ore bodies. Amongst other things the time for each separation stage is determined in the batch tests; however, the flotation process is usually carried out in a continuous manner. Show algebraically how you would relate the batch flotation time to the mean residence time in a continuous circuit.

7) Gravity separations are still common in the mineral industry. Describe the generic types of gravity separators and indicate the mechanism by which they function. Be quantitative wherever possible.



398-71 REVEREL & EMBER CO. Semi-Logarithmic, 3 Cycles X 10 to the Inch. 5th lines accorded.

10. 8...

											_							_						
	-1414			==	i :	4				1	<u> </u>	1		-			1	Ę	===		= =	=		
				<u> </u>				进			$\pm \pm$								=	=			==:	
				1		i				+ ا	٠. ــــــــــــــــــــــــــــــــــــ			+++-	 -		++++							
			7			EI.		===	, 1	===					\equiv		1					<u> </u>	==-	
				-		-:-				2				11.	بنني		 			-1	-,			
				T				33						Ε.	=	===	==		==		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 	=;	احجنا	
			-1				-	 :-		7.		==		11:		111			<u>===</u>	+				
	- 1	11111	<u>-1÷1-</u>	<u> </u>	-1-							==	-		Τ.			11-1						
	1444		1	3							1	Li		76										
Harris Harris		- 1-	1	F-T			411		1		<u> </u>			: : : :				1						
		-11-11	<u> </u>	151	Hit								3-1-1				-			<u> </u>				3-1-
<u> </u>			7-	جب ب		-					117	$\Box \Box$		117		ببن	1			L1	-1 :	- 	; 	
			 			H	噩												1:			===		
	-1	+ + - + - + - + - + - + - + - + - + - +		-		خنبنا	ļ : -			; ;;;	 			+++-	+++			1 1 1	777	+1-				
				E								EH.	= :						===					
					4 1				11-1-1-	1111	 	 		_		***	4		-444		*		4-1-4-	
	ا::::ا		! 	111						111	1	1	$\pm \pm$	==		₩.	H					==	++++	
		11111				1					<u> </u>	<u> </u>		111								- 1	==	
	╌┶┸╪┿╽		<u> </u>	1-11			- -	<u> </u>		333			71	===		, 	7		4				-11	
							Ξ.					-		===					+			==		
		11:4	~ } 	H . + +	+++	 	<u> </u>	∐ , ∔	+++	41,-	بننا		++++		144		1		1					:::=
			- 1	F		H.;							7.7	##		-11								=
	<u></u> 1		1	###				 - !+		##		11:	====	#1	-44	##		生二	1			<u>=</u> +1		三
	-			片芒		H	1	\equiv			;;;			- [##	<u> </u>	===	#	127	#35		- 1	
						H ===		1		111		E		1:::		<u> </u>			丗		1733 -	===		
	╪┞╩┰┦	+4-	1	 		⊭≓	#==		1	779	=	7	4	##		+++	1 -	71	1	17	++-+			
	平田		₩	Ti-		뜨		F. :	1	\equiv		EH		##		≕			77				<u> </u>	
				##	H. Fr		H-;-	-11-	1			11.		1	1	1			=	1			1	\equiv
	#[][[#===	#=	莊莊		HE:	1	III.	Ш	#=	111	1		荦	+	: 1	Щ.		==		447.5	느	<u>#</u> [[<u>+</u>
		#111E	7 E 🗀	1							<u> </u>	HH.			===	H	三		<u> </u>	EEF	T .	\equiv		\equiv
			<u> </u>	ĽТ		<u> </u>	rt et	1	##	<u> </u>		##		t::ī	<u> H</u> H	##						=-	+	\equiv
	- 112-11			1				1	111	1	1		1				44-4				.,_,.			===
	111111				<u> </u>				1.1.				+	<u></u>	4.1								==	=
		111		H			<u> </u>	ĻΞ	<u> </u>		1	ĽŦ.	التبار	日二	<u> </u>	11.			4.					<u> </u>
													4-14	===	3	\equiv	===		\equiv					=
						II-F-			-			1				프-	===		111			<u>; </u>		===
	+		===	+							\equiv		===	==			==	===		===		#	+	
									1	1				ΞΞ		<u> </u>					<u> </u>	==[=
							-										1. L	+						==
<u> </u>			+			===			111	1	1	#	- II -						<u>⊟</u> +	++	H-H-			
				1						J- 1-							-			. 1117	1	77		
		1	- E1			±==	EE			並	<u>:</u> :	Η	I i	-1		+11-		+1	-1				<u> </u>	
			-			E4.		1-1-1		f	4-1-		+++	1111	-i i-		+1 -	1-1-1		-, L	5111			
	_ _:-:-}	t <u>: </u>		ببنا	4.1.	+11	+ +		#	711	<u> </u>	++++	1::::	<u> </u>	##	##;	71,17	###	:		+	1:1		ш
H-1-1-1-1-	- + - 1 - 1			1.7.3	+++	11E	1.1	11.			4	111	111	===	++ +		+++1		:::::	75.4	+1 -+ +		.11	112
		7,444.4	⋍╞╧╼╤┦		+ !					###!	11++			1111	+==	` #†	井立	44-51	###	1.11	11112-			
			Harin.	+	1	1	1.1.	#1	Ļ	#	111	1	1,11 1.	田田	1111	11:1	7:11	11:11		+	!!-:: <u>+</u>			+
		11.11.					+++	-14		II	11:11	[1	Ш		Hi			+1-1-				+ - !	\pm
	-1:::+		-	1:11				1+				-		 		†! #		+++++	냂山		**==	土		#1
▐▐ ┸╃┸╼╈╃╺╒╃┡╇╅╈		+++ - -							-+	+		ETIE.		+11	F.F.1	Æί		Π_{++}	4	++ :		\pm	! :-!	
		1	<u> </u>			7111		T						Н.,	11:11		11-1		44			1.1		F::-
			<u> </u>			+								- 11-	##	Ţ ‡‡‡	-+++			7:50		+++		
						111			##					 • • •	HH	TT:	EH.				: 			#:1
			1:1:										! 	##	1711	###	117						_ 1 1 1	##
		1:4:	±∦≕i	<u> </u>			11:11	H-I	ĦΕ	###	HH	444	Ή÷Γ	$\Box \Box \Box$	<u> </u>	[#]	++-+		<u></u>	보다	البيد			围
			422						开厅		1111					==		프크	=					151
			出土	<u> </u>	HH.			H114		HH	世		<u>+::::</u> :::	41.		-4-1	H		!	::: <u>:</u>	- [] [1	1.1	끊비
			4	1111				111	+	H	##	#177				+ 1	4			;				
				1:11			HH.		77	144	H.E.		Fir		HI.	:=:			<u> </u>				FFF	
			11:11	<u> H</u>		##	1211	-44	1	 		曲岩		++L+ ::::r		##	##=	1					14:44	
	- -	4444	+1747	riii'		11	HTE	[i+ti	FF.F	HH	旺	##11	447	:TE	111	##!			أك	;;;;	评用	T	714	랲테
			法法	III	11.5		<u> </u>		##	7	15:21	EE:				##			12			<u></u> F	7	H
			1114	Hirt	出印		HHT	HJE	11:17	1	ri É		111:1	1:11	Η···Fi	##	11-11	<u></u>			###	+1	444	끍귀
				THE	1	1111	F##	T iT	HI!	HIII	H		1:1:F	111	HI	##				77				11.4
			<u> </u>	171			THE P			ĦĔ	莊莊	ш		HIE	性出		Ξij			-		ΞĿ		
				##		Ŀ	Ľijij	世井		##	<u> </u>	Eit.	1111	144		#	ا نوعا			11:11				
		HIFF		TT:	FFF.	田田		H 11		H	H	Щi	jE,	HT.	1	 ‡#	<u></u>			-1	1	<u>-</u> ;F		=:4
++++++++++++++++++++++++++++++++++++++		THILE		HH	Ш	H	<u>[::::</u>	17.11		EHE	T L II		<u> </u>			끊迫	اتت		Ţij	15:31			11:	
		<u> </u>	155	μН	ΗT	144			4.4	 	11#	++.[+	###	<u> </u>	44	#==	υĘΞ	ᆣ井	لتب				<u> </u>	(البنية
			HIH	正莊	HI		山井	HIII	HH	HT.	HIL	1.11	LTEEF	H		다뉴	1.1			莊湯		##		
	┍┷╏╍┋┧╌┟	L <u>L -</u> _		####	<u> </u>	1111	###	11.4.	L##.FF.	ЩĦ.	+++4		+++[1			11-7	44.44						<u> </u>
		 	ده سایدا						+	1777	1111							; ;		15-55				
				ЦЪ			1,11	計日記			11.	 - - 	†÷† L	<u>;</u> }};;	++++	;;;;l		F	1,11		-:	1.5	1-:	النات
																11			1 ::	<u></u>	441.	1.=}:		
				141.5.1					野群				† † 						1		441.	1.=}:		
				141.5.1	1 I + 🗀	├ } `													1 ± = -j.				1	
				盐	1 I + 🗀				. خ ـنــــــــــــــــــــــــــــــــــ		. ښندن د ا								1 :: ; : i. : : : ;					

:------------. <u>.</u> i i i i i i 2. 1117711 _____ ----Ţ -- <u>- 14</u> - | T. T. 10_ :=| = :id se promin === ----Ξ 2.5_ ---:==: 1.5. -. . . . 1.5 3