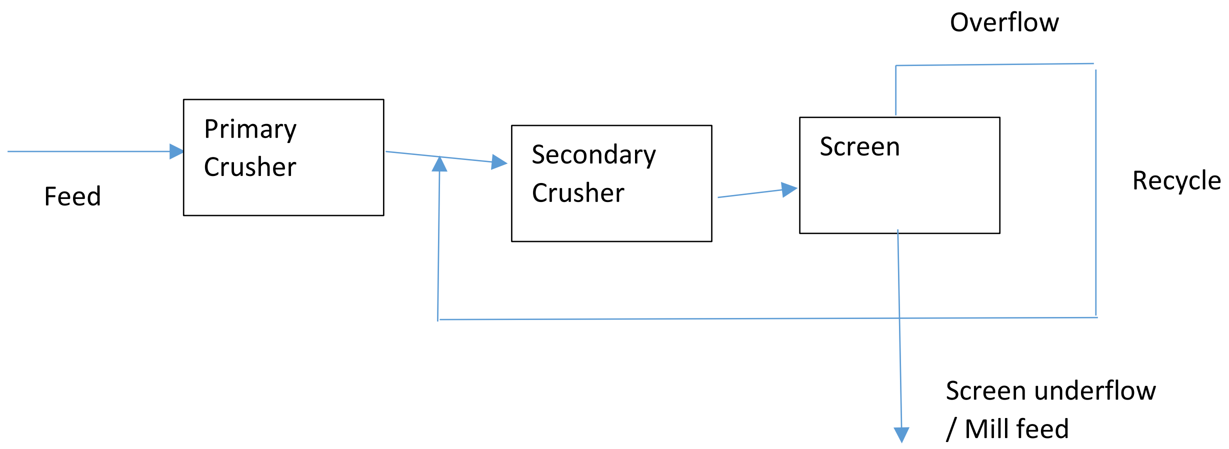
Question 1

a)



b)

It is typically cheaper to transport material by conveyor rather than hauling it, but it must be crushed before it can be conveyed.

c)

	Feed	Crusher product	Recycle	Crusher Feed	Crusher Product	Overflow	Underflow
+1 cm	1020	714	X	714+X	(714+X)*0.5	(714+X)*0.5*0.8	(714+X)*0.5*0.2
-1 cm	180	486	Y	486+Y	(486+Y) + (714+X)*0.5	((486+Y) + (714+X)*0.5)*0.3	((486+Y) + (714+X)*0.5)*0.7

X = (714+X)*0.5*0.8

Y = ((486+Y) + (714+X)*0.5)*0.3

X = 476 tph

Y = 463.3 tph

	Feed	Crusher product	Recycle	Crusher Feed	Crusher Product	Underflow
+1 cm	1020	714	476	1190	595	119
-1 cm	180	486	463.3	949.3	1544.3	1081

Percent passing 1cm = 1081 / 1200 ≈ 90.1%

d)

Basis - 100

	Feed	UF	OF
+1cm	70	X * 0.2	Y * 0.9
-1cm	30	X * 0.8	Y * 0.1

70 = X * 0.2 + Y * 0.9 ---> (1)

30 = X * 0.8 + Y * 0.1 ---> (2)

4 * (1) – (2)

250 = 3.5 Y

Y= 250 / 3.5 ≈ 71.43

X ≈28.57

Mass recovery to the overflow is 71.43%

e) Solid feed to mill is 1200 tph

Volume solid rate into mill = 1200 / 2.7 =444.444 m^3/hr

Total Volumetric Rate = 444.444/0.3 = 1481 m^3/hr

Volumetric Water Into Mill = 1481 * 0.7 = 1037 m^3/hr

Water Added = 1037 – 1200*0.1/0.9 = 903.7 m^3/hr

f)

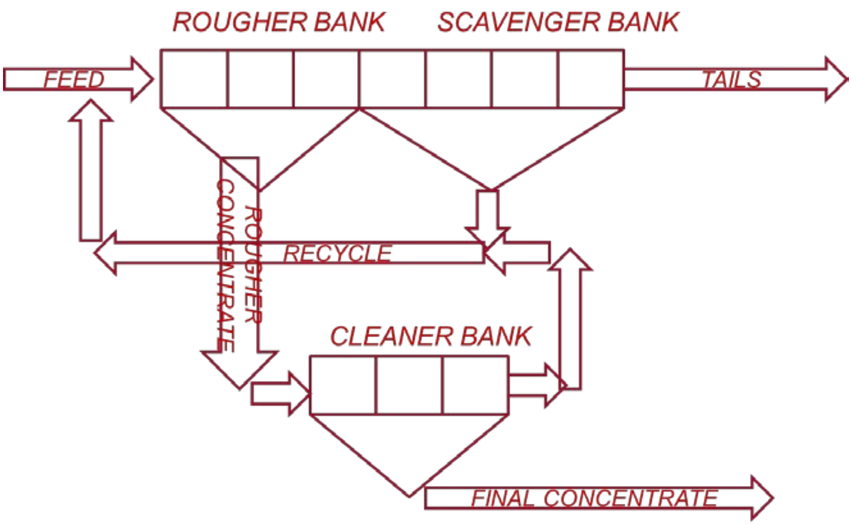
P = 1200 * 15 *(sqrt(100/90)-sqrt(100/8000)) = 16961 kW

Question 2

a)

	Feed	Cell 1 Conc	Tails	Cell 2 Conc	Tails	Cell 3 Conc	Tails	Cell 3 Conc	Tails
Copper	15	2.4	12.6	1.5	11.1	1	10.1	0.6	9.5
Total	1000	8	992	6	986	5	981	4	977
Cummulative									
Copper		2.4		3.9		4.9		5.5	
Total		8		14		19		23	
Recovery		0.16		0.26		0.32666667		0.36666667	
Grade		0.3		0.27857143		0.25789474		0.23913043	

b)



c)

	Feed	Recycle	Rougher Feed	Rougher Tails	Scavenger Tails
Copper	100	X	100 + X	(100 + X) * 0.2	(100 + X) * 0.2 *0.5

	Rougher Conc	Scavenger Conc	Cleaner Conc	Cleaner Tails
Copper	(100 + X) * 0.8	(100 + X) * 0.2 *0.5	(100 + X) * 0.8 * 0.6	(100 + X) * 0.8 * 0.4

X = (100 + X) * 0.2 *0.5 + (100 + X) * 0.8 * 0.4

X * (1 – 0.2*0.5 - 0.8*0.4) = 100 * (0.2*0.5 + 0.8 * 0.4)

X = 72.41

Cleaner Conc = 82.75%

d)

Overall recovery would drop and the concentrate grade would increase.

e)

The feed rate to all the banks would increase and all the feed grades would also increase.

f)

If the metal price went up, the optimum recovery would increase, with a corresponding decrease in the grade. This is because at the optimum, the cost of treating anther unit of recovered metal is equal to the value of the metal. As you increase the metal price this means that you can afford to recover more, with a corresponding increase in the costs as the grade decreases before the cost of additional recovery equals the value of the metal.

Question 3

a)

Read off the graph:

d_{50} = 110microns

Bypass ratio = 15%

b)

Size Intervals microns	Representative microns	Fraction in Interval	Partition Number Read off graph
+150-212	178	5	0.9
+105-150	125	25	0.62
+74-105	88	50	0.37
+53-74	63	5	0.24
-53	27	15	0.16

Representative microns	Mass in UF	Mass in OF	Cumulative UF	Cumulative OF
178	4.5	0.5	100.0	100.0
125	15.5	9.5	89.3	99.1
88	18.5	31.5	52.5	82.7
63	1.2	3.8	8.6	28.3
27	2.4	12.6	5.7	21.8
Total	42.1	57.9		

c)

Mass recovery = 42.1%

d)

As the cyclone wears its diameter will increase, this will cause the cut size to increase, as well as the mass recovery to the underflow.

e)

W_F is volumetric flowrate of water in the feed

W_F / 0.7 * 0.3 * 2.5 + W_F = 100

W_F = 48.27 tph or m^3/hr

Work in a volume Basis

	Feed	UF	OF
Water	48.27	X * 0.6	Y * 0.8
Solid	=48.27/0.7*0.3 = 20.69	X * 0.4	Y * 0.2

48.27 = 0.6 * X + 0.8 * Y ---> (1)

20.69 = 0.4 * X + 0.2 * Y ---> (2)

4*(2) - (1)

X = 34.49

Y = 34.49

UF

Water = 34.49 * 0.6 = 20.7 tph

Solid = 34.49 * 0.4 * 2.5 = 34.49 tph

Question 4

a)

Oxides and low grade sulphides to leach. Higher grade sulphides to concentrator.

b)

Total amount added to each lift (1/4 of 8 month's worth of feed) = 5 000 *365 * 8 / 12 / 4 = 304 166 t

Volume = 304 166/ (2.6 * (1-0.2)) = 146 232 m^3

Area of heap = 146 232 / 10 = 14 623 m^2

c)

Copper added to heap per hour = 5000 * 0.01 /24 = 2.08 tph

Copper in pregnant solution = 900*(1-0.05) * 2.1 = 1795.5 kg/hr

Copper extracted by solvent = 1795.5 * 0.9 = 1.61 tph

Avergage copper recovery = 1.61 / 2.08 ≈ 77%

d)

Copper extracted = 1795.5 kg/hr

Change in concentration = 6 – 2 = 4 kg/m^3

Flowrate = 1795.5 / 4 = 448.9 m^3/hr

e)

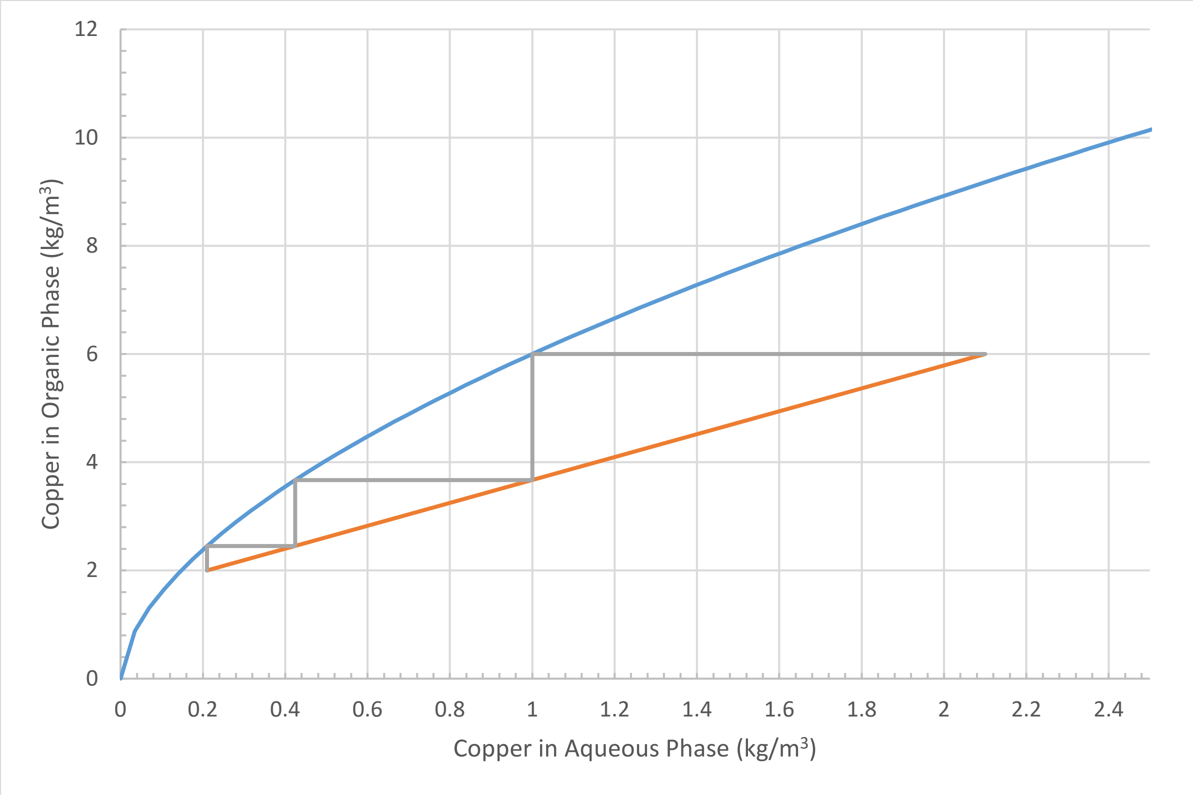
Aqueous concentration in = 2.1 kg/m^3

Aqueous concentration out = 2.1*(1-0.9) = 0.21 kg/m^3

Organic concentration in = 2 kg/m^3

Organic concentration out = 6 kg/m^3

Draw line of graph connecting Aqueous in/Organic out with Aqueous out/Organic in



Count number of steps to give a total of 3 equilibrium stages.

f)

Smelting – partially reduces the copper and allows density separation of a matt and slag phase

Product is a matte containing copper/copper sulphide species and some impurities

Converting - Completes the reduction of the copper followed by skimming to allow further gravity separation. Product of this is blister copper, which contains too many impurities to be sold.

Blister copper cast into electrodes

Electro-refining to produce a saleable copper product and anode slime, which contains impurities, but also can contain by-products such as precious metals.