HW5

Question 1

b)

n	p	time of p2p	speedup of p2p	efficiency of p2p	time of collective	speedup of collective	efficiency of collective
1000	1	2.9e-05	1	1	2.8e-05	1	1
1000	2	2.3e-05	1.26086956521739	0.630434782608696	1.6e-05	1.75	0.875
1000	5	0.004293	0.00675518285581179	0.00135103657116236	1.2e-05	2.33333333333333	0.466666666666667
1000	10	1.8e-05	1.61111111111111	0.161111111111111	1.1e-05	2.54545454545455	0.254545454545455
1000	20	0.010692	0.00271230826786382	0.000135615413393191	0.016411	0.00170617268905003	8.53086344525014e-05
1000	100	0.028907	0.00100321721382364	1.00321721382364e-05	0.016427	0.00170451086625677	1.70451086625677e-05
1000	250	0.125222	0.000231588698471515	9.26354793886058e-07	0.021053	0.00132997672540731	5.31990690162922e-06
1e+05	1	0.002692	1	1	0.002695	1	1
1e+05	2	0.001359	1.98086828550405	0.990434142752024	0.001345	2.00371747211896	1.00185873605948
1e+05	5	0.005223	0.515412598123684	0.103082519624737	0.000583	4.62264150943396	0.924528301886792
1e+05	10	0.007583	0.355004615587498	0.0355004615587498	0.004042	0.666749134092034	0.0666749134092034
1e+05	20	0.014449	0.186310471312894	0.00931552356564468	0.006197	0.434887848959174	0.0217443924479587
1e+05	100	0.112112	0.0240117025831312	0.000240117025831312	0.025561	0.105434059700325	0.00105434059700325
1e+05	250	0.123364	0.0218216011153983	8.72864044615933e-05	0.02957	0.0911396685830233	0.000364558674332093
1e+07	1	0.269535	1	1	0.269284	1	1
1e+07	2	0.134653	2.00170066764201	1.00085033382101	0.134529	2.00167993518126	1.00083996759063
1e+07	5	0.05378	5.01180736333209	1.00236147266642	0.053943	4.99201008471906	0.998402016943811
1e+07	10	0.026997	9.98388709856651	0.998388709856651	0.026957	9.98939051081352	0.998939051081352
1e+07	20	0.025135	10.7234931370599	0.536174656852994	0.021628	12.4507120399482	0.622535601997411
1e+07	100	0.035039	7.69242843688462	0.0769242843688462	0.018083	14.8915556047116	0.148915556047116
1e+07	250	0.048019	5.61309065161707	0.0224523626064683	0.013464	20.0002970885324	0.0800011883541295

When the number of processors is small, collective and point-to-point show similar performance. As the number of processors goes up, collective version become faster than point-to-point version.

From the data above, when n is large, speed up of both point-to-point and collective increase stably. However, when n is small, the speed up is not stable and the performance is not good as expected, which may because the code is not so effective and need to be improved.

Besides, according to the formula in c), when n is large, the time is decided by O(n/p). So the time decrease by p. Also, when n is small, O(log(p)) decide the time and the time increase by p.

c)

```
# input data
n <- c(rep(1000,7), rep(100000, 7), rep(10000000, 7))
p <- rep(c(1,2,5,10,20,100,250),3)
p2p <- c(0.000029,0.000023,0.004293,0.000018,0.010692,0.028907,0.125222,
         0.002692,0.001359,0.005223,0.007583,0.014449,0.112112,0.123364,
         0.269535,0.134653,0.053780,0.026997,0.025135,0.035039,0.048019)
clct <- c(0.000028,0.000016,0.000012,0.000011,0.016411,0.016427,0.021053,
          0.002695,0.001345,0.000583,0.004042,0.006197,0.025561,0.029570,
          0.269284,0.134529,0.053943,0.026957,0.021628,0.018083,0.013464)
```

```
x1 <- n/p
x2 <- log2(p)

mydata <- data.frame(cbind(x1,x2,p2p,clct))
# fit the linear model
fit1 <- lm(p2p~x1+x2-1, mydata)
summary(fit1)
fit2 <- lm(clct~x1+x2-1, mydata)
summary(fit2)
```

For p2p, we have the formula

$$T_{p2p}(n,p) = 2.595e^{-8} \times \frac{n}{p} + 8.641e^{-3} \times \log_2(p)$$

For collective, we have the formula

$$T_{collective}(n,p) = 2.667e^{-8} \times \frac{n}{p} + 2.395e^{-3} \times \log_2(p)$$

We can observe that the collective version has smaller scale of log(p). Because MPI_Reduce is an all-to-one

command, which is effective than point-to-point and can reduce the time of communicate. Besides, they have similar scale of n/p, which may due to the same computing processes.