Exercise 1
Question 1

The IP address of gaia.cs.umass.edu is 128.119.245.12, and the port number for this connection is 80.

The IP address of the client computer is 192.168.1.102 and the port number is 1161.
Question 2

Sequence number: 232129013
Question 3 & Question 4

Sequence Number	Send Time	ACK Receive Time	SampleRTT	EstimatedRTT	Length(bytes)
232129013	0.026477	0.053937	0.02746	0.02746	565
232129578	0.041737	0.077294	0.035557	0.028472	1460
232131038	0.054026	0.124085	0.070059	0.03367	1460
232132498	0.054690	0.169118	0.114428	0.043765	1460
232133958	0.077405	0.217299	0.139894	0.055781	1460
232135418	0.078157	0.267802	0.189645	0.072514	1460

When alpha is set to 0.125, EstimatedRTT = 0.875 * EstimatedRTT + 0.125 * SampleRTT
Question 5

Minimum amount: 5840 bytes

No throttle was made due to the lack of buffer space.
Question 6

There was no retransmitted segments could be seen in the trace file.

Check the sequence number of the trace file, it could be found that all sequence numbers are in ascending order, meaning there is no segment that was retransmitted.
Question 7

The data that receiver typically acknowledge in an ACK is 1460 bytes.

```
87  2.029069    128.119.245.12    192.168.1.102    TCP    60 80 → 1161 [ACK] Seq=883061786 Ack=232190097 Win=62780 Len=0
88  2.126682    128.119.245.12    192.168.1.102    TCP    60 80 → 1161 [ACK] Seq=883061786 Ack=232193017 Win=62780 Len=0
```

232193017-232190097 = 2920 = 1460 * 2
Question 8

According to the picture below, total data amount = 232293103-232129013=164090 bytes, total transfer time = 5.45583-0.026477 = 5.429353s.

Thus, we have throughput = 164090/5.429353 = 30222.75 bytes/s = 30.223 kbytes/s

```
   4 0.026477      192.168.1.102      128.119.245.12      TCP      619 1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 Win=17520 Len=565 [TC
   5 0.041737      192.168.1.102      128.119.245.12      TCP     1514 1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=17520 Len=1460 [TC
   6 0.053937      128.119.245.12     192.168.1.102       TCP       60 80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0
   7 0.054026      192.168.1.102      128.119.245.12      TCP     1514 1161 → 80 [ACK] Seq=232131038 Ack=883061786 Win=17520 Len=1460 [TCP seg
   8 0.054690      192.168.1.102      128.119.245.12      TCP     1514 1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17520 Len=1460 [TCP seg
   9 0.077294      128.119.245.12     192.168.1.102       TCP       60 80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=8760 Len=0
  10 0.077405      192.168.1.102      128.119.245.12      TCP     1514 1161 → 80 [ACK] Seq=232133958 Ack=883061786 Win=17520 Len=1460 [TCP seg
  11 0.078157      192.168.1.102      128.119.245.12      TCP     1514 1161 → 80 [ACK] Seq=232135418 Ack=883061786 Win=17520 Len=1460 [TCP seg
  12 0.124085      128.119.245.12     192.168.1.102       TCP       60 80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0
  13 0.124185      192.168.1.102      128.119.245.12      TCP     1201 1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 Win=17520 Len=1147 [TC
```

```
▶ Flags: 0x018 (PSH, ACK)
  Window size value: 17520
  [Calculated window size: 17520]
  [Window size scaling factor: −2 (no window scaling used)]
  Checksum: 0x1fbd [unverified]
  [Checksum Status: Unverified]
  Urgent pointer: 0
▶ [SEQ/ACK analysis]
▼ [Timestamps]
    [Time since first frame in this TCP stream: 0.026477000 seconds]
    [Time since previous frame in this TCP stream: 0.003212000 seconds]
  TCP payload (565 bytes)
```

```
 202 5.455830      128.119.245.12     192.168.1.102       TCP       60 80 → 1161 [ACK] Seq=883061786 Ack=232293103 Win=62780 Len=0
 203 5.461175      128.119.245.12     192.168.1.102       HTTP     784 HTTP/1.1 200 OK  (text/html)
 206 5.651141      192.168.1.102      128.119.245.12      TCP       54 1161 → 80 [ACK] Seq=232293103 Ack=883062516 Win=16790 Len=0
 213 7.595557      192.168.1.102      199.2.53.206        TCP       62 1162 → 631 [SYN] Seq=234062521 Win=16384 Len=0 MSS=1460 SACK_PERM=1
```

```
  [Next sequence number: 883061786]
  Acknowledgment number: 232293103
  0101 .... = Header Length: 20 bytes (5)
▶ Flags: 0x010 (ACK)
  Window size value: 62780
  [Calculated window size: 62780]
  [Window size scaling factor: −2 (no window scaling used)]
  Checksum: 0x44a8 [unverified]
  [Checksum Status: Unverified]
  Urgent pointer: 0
▶ [SEQ/ACK analysis]
▼ [Timestamps]
    [Time since first frame in this TCP stream: 5.455830000 seconds]
    [Time since previous frame in this TCP stream: 0.007943000 seconds]
```

Exercise 2
Question 1

2818463618

Question 2

Sequence number of the SYNACK segment sent by the server to the client: 1247095790

The value of the Ack field in the SYNACK segment: 2818463619

The server added 1 to the ISN from the client.

Question 3

Sequence number: 281863619

ACK number: 1247095791

This segment does not contain any data

Question 4

Client. It could be seen that the client sent a segment with FIN.

This is a simultaneous close. According to the Seq and ACK numbers in the FIN segments, ACK was not incremented by 1 in the FIN generated, which means that both the client and the server have initiated active close simultaneously.

Question 5

Client to Server:

The number of the last ACK received by the client is 2818463653, ISN = 2818463618

Thus total data sent = 2818463653 - 2818463618 - 2 = 33 bytes

Server to Client:

Last received ACK number: 1247095832, ISN = 1247095790

Total data sent = 1247095832 - 1247095790 - 2 = 40 bytes