Q3:

One of the advantages that concrete structures have over steel structures is fire resistance (which is to say, steel becomes weak when heated). The time, *T*T, that it takes a steel girder to reach certain temperature (where its strength becomes too low to support its load) in a fire is, however, random. Suppose that for design code development, the following data has been gathered on the time T in hours:

0.7361.0110.8631.0640.8651.1090.9131.1320.9151.1400.9371.1530.9831.2531.0071.3940.7360.8630.86
50.9130.9150.9370.9831.0071.0111.0641.1091.1321.1401.1531.2531.394

(a) Calculate the values of the following statistics: sample mean, sample median, sample standard deviation, sample range, the five-number summary and the interquartile range.

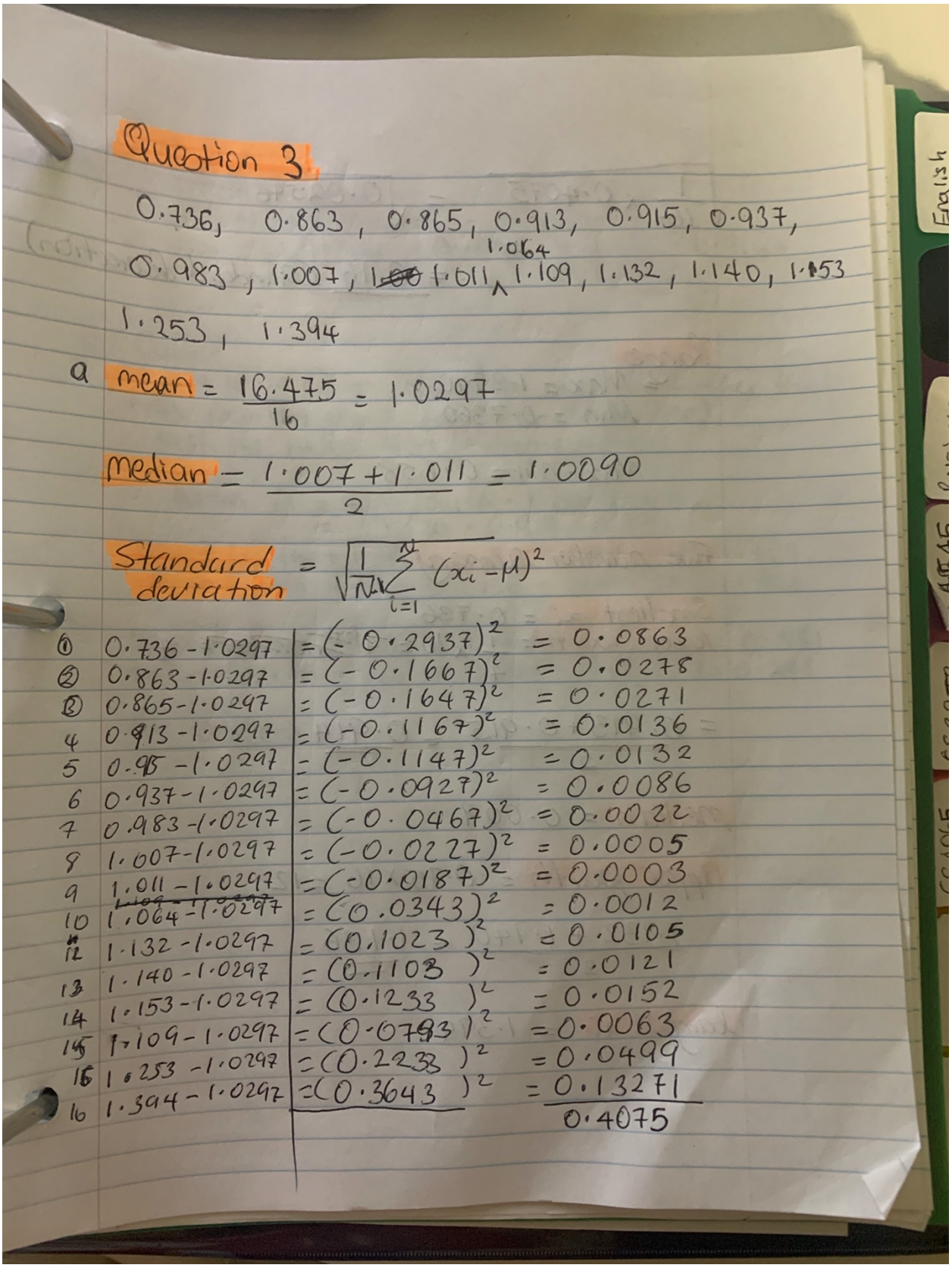
(b) Are there any outliers? Why?

(c) Construct a histogram, a stem-and-leaf diagram and a boxplot for these data.

(d) Based on the graphs in (c), what is the shape of the distribution: it is symmetric, skewed to the left or skewed to the right?

Answers:

a)



Question 3

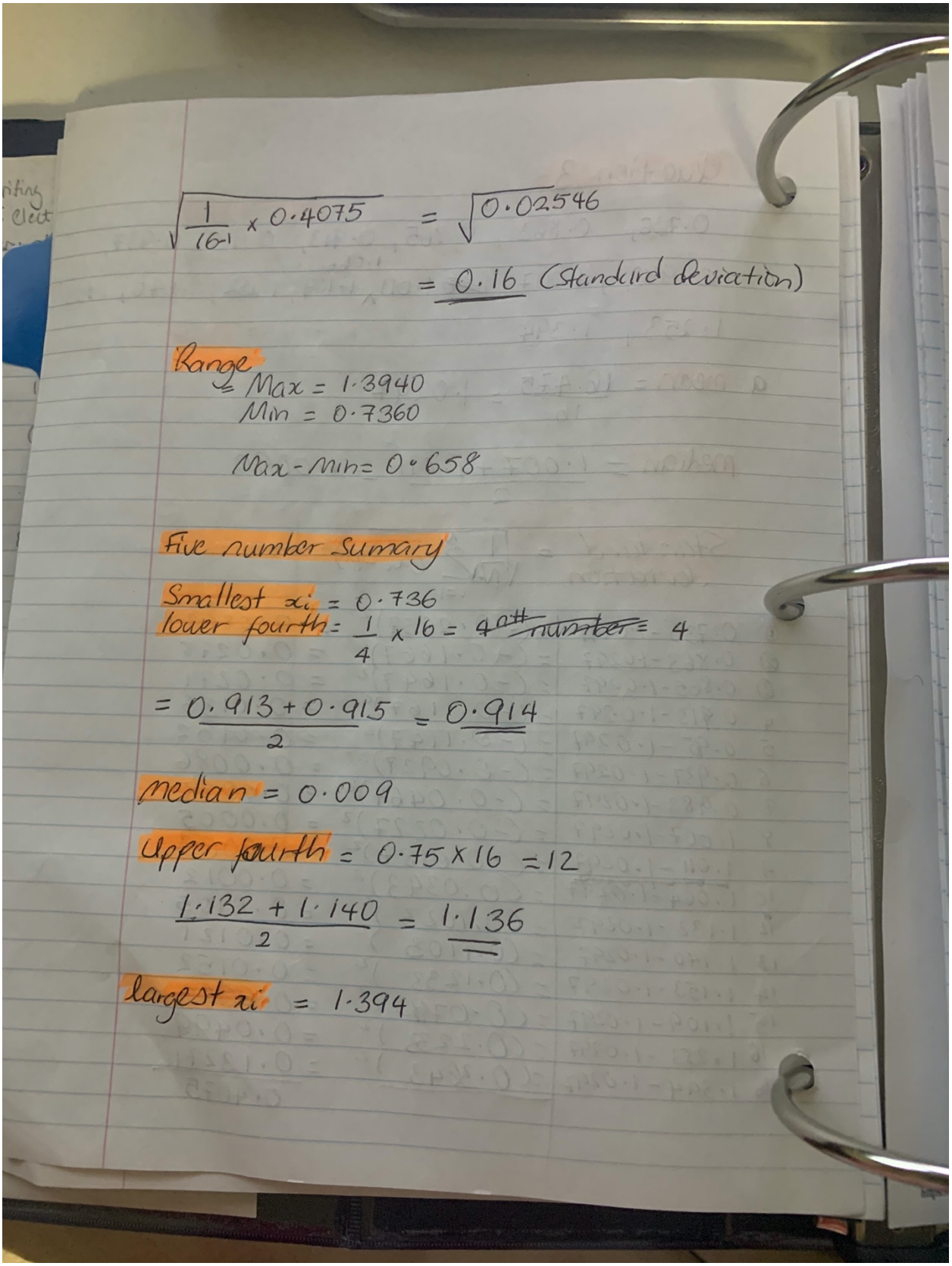
0.736, 0.863, 0.865, 0.913, 0.915, 0.937,
0.983, 1.007, ~~1.00~~ 1.011, 1.064, 1.109, 1.132, 1.140, 1.153
1.253, 1.394

a **mean** $= \frac{16.475}{16} = 1.0297$

median $= \frac{1.007 + 1.011}{2} = 1.0090$

Standard deviation $= \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \mu)^2}$

1	$0.736 - 1.0297$	$= (-0.2937)^2$	$= 0.0863$
2	$0.863 - 1.0297$	$= (-0.1667)^2$	$= 0.0278$
3	$0.865 - 1.0247$	$= (-0.1647)^2$	$= 0.0271$
4	$0.913 - 1.0297$	$= (-0.1167)^2$	$= 0.0136$
5	$0.915 - 1.0297$	$= (-0.1147)^2$	$= 0.0132$
6	$0.937 - 1.0297$	$= (-0.0927)^2$	$= 0.0086$
7	$0.983 - 1.0297$	$= (-0.0467)^2$	$= 0.0022$
8	$1.007 - 1.0297$	$= (-0.0227)^2$	$= 0.0005$
9	$1.011 - 1.0297$	$= (-0.0187)^2$	$= 0.0003$
10	$1.064 - 1.0297$	$= (0.0343)^2$	$= 0.0012$
12	$1.132 - 1.0297$	$= (0.1023)^2$	$= 0.0105$
13	$1.140 - 1.0297$	$= (0.1103)^2$	$= 0.0121$
14	$1.153 - 1.0297$	$= (0.1233)^2$	$= 0.0152$
15	$1.109 - 1.0297$	$= (0.0793)^2$	$= 0.0063$
16	$1.253 - 1.0297$	$= (0.2233)^2$	$= 0.0499$
	$1.394 - 1.0297$	$= (0.3643)^2$	$= 0.13271$
			0.4075



$$\sqrt{\frac{1}{16-1} \times 0.4075} = \sqrt{0.02546}$$

$$= 0.16 \text{ (Standard deviation)}$$

Range

Max = 1.3940
Min = 0.7360

Max - Min = 0.658

Five number Sumary

Smallest x_i = 0.736

lower fourth = $\frac{1}{4} \times 16 = 4^{th}$ number = 4

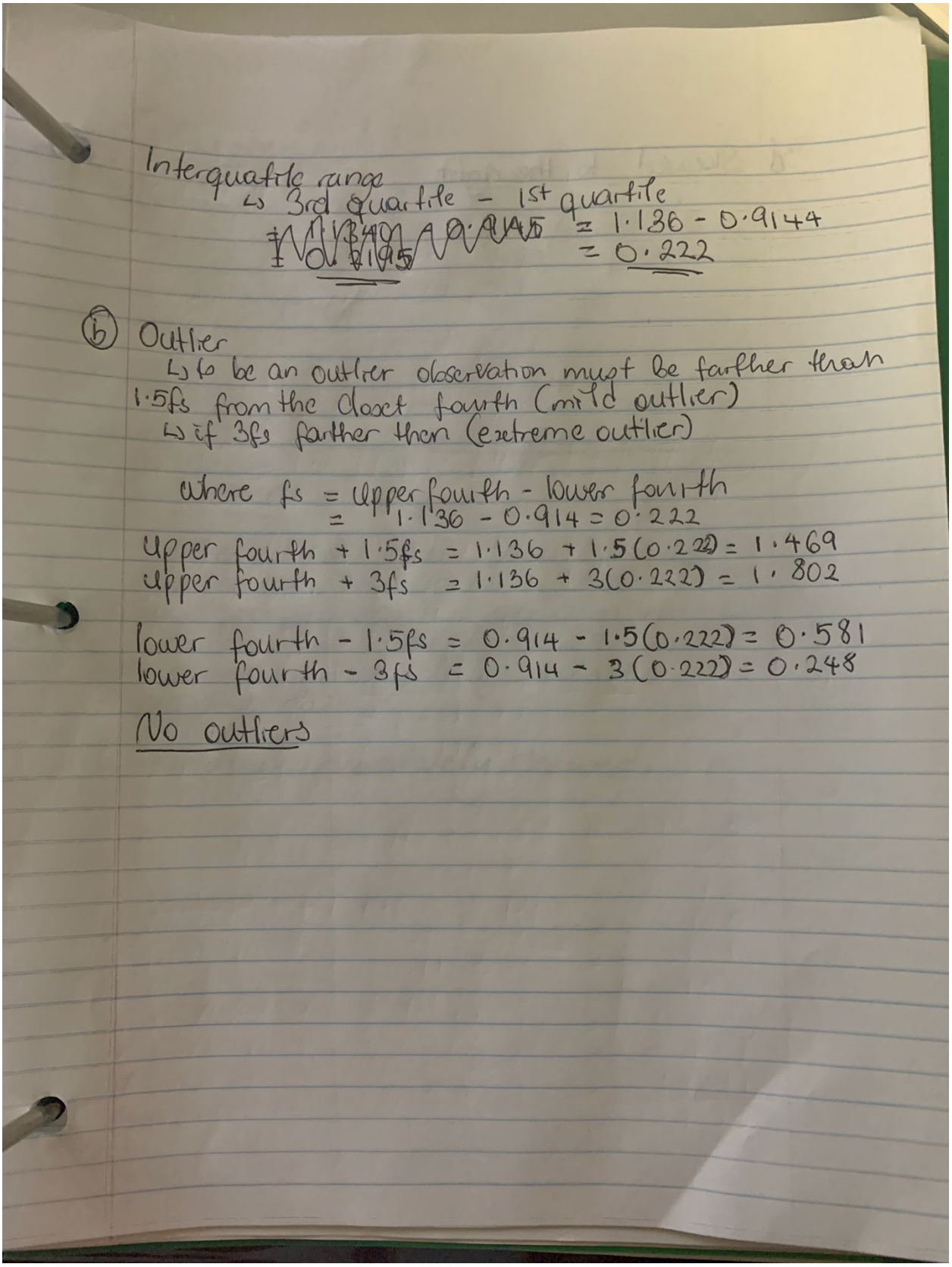
$$= \frac{0.913 + 0.915}{2} = 0.914$$

median = 0.009

Upper fourth = $0.75 \times 16 = 12$

$$\frac{1.132 + 1.140}{2} = 1.136$$

largest x_i = 1.394



Interquartile range
↳ 3rd quartile − 1st quartile
= 1.136 − 0.9144
= 0.222

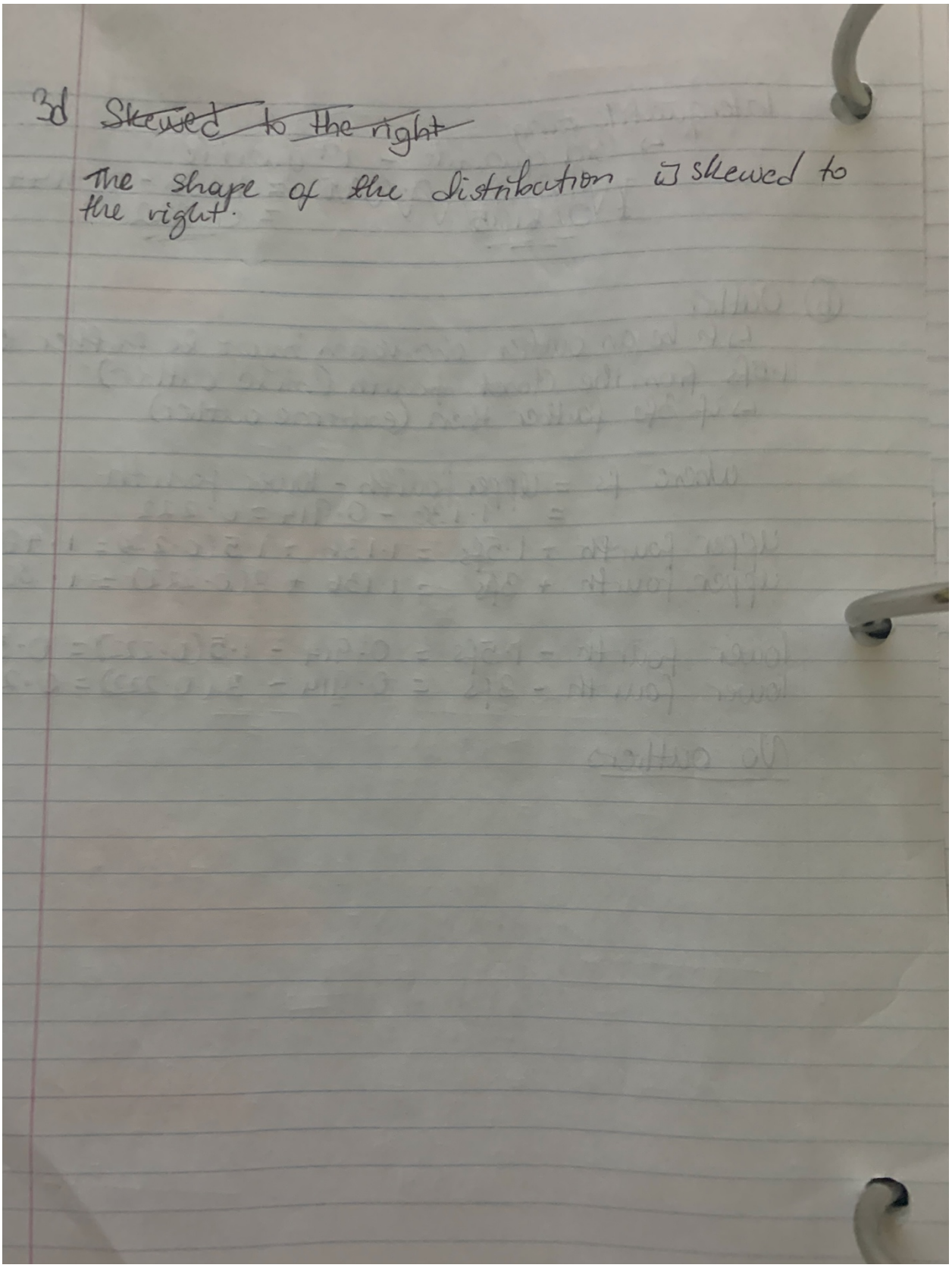
(b) Outlier
↳ to be an outlier observation must be farther than 1.5fs from the closet fourth (mild outlier)
↳ if 3fs farther then (extreme outlier)

where fs = upper fourth − lower fourth
= 1.136 − 0.914 = 0.222

upper fourth + 1.5fs = 1.136 + 1.5(0.222) = 1.469
upper fourth + 3fs = 1.136 + 3(0.222) = 1.802

lower fourth − 1.5fs = 0.914 − 1.5(0.222) = 0.581
lower fourth − 3fs = 0.914 − 3(0.222) = 0.248

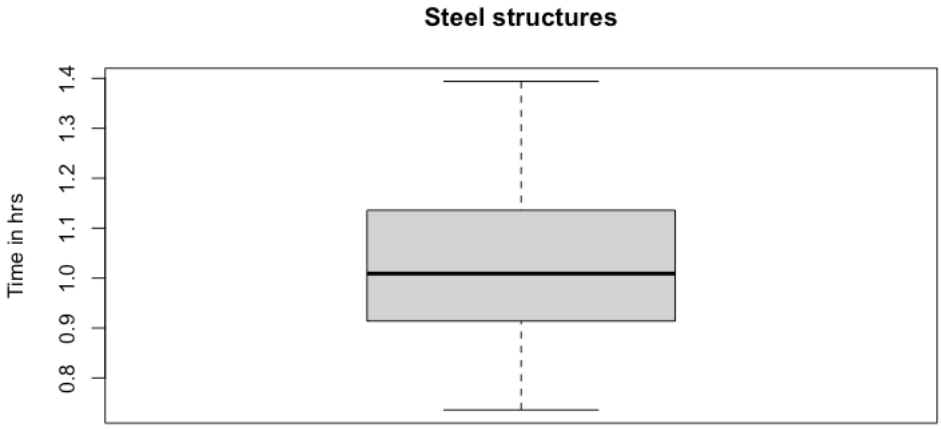
No outliers

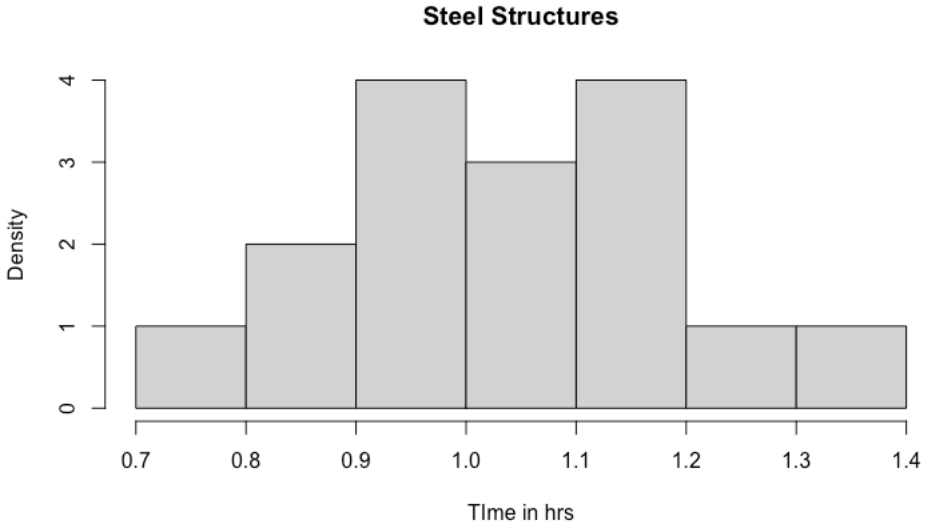

3d ~~Skewed to the right~~
The shape of the distribution is skewed to the right.

Code in R:

```
# question 3a)
timeForLowSupport = c(0.736, 1.011, 0.863, 1.064, 0.865, 1.109, 0.913, 1.132,
                      0.915, 1.140, 0.937, 1.153, 0.983, 1.253, 1.007, 1.394)
# giving the mean, 1st, 3rd quartiles, median, mean and max
timeSummarry = summary(timeForLowSupport)
timeSummarry
# getting the standard deviation
timeSTD = sd(timeForLowSupport)
timeSTD
# five number summary
timeFiveSummary = quantile(timeForLowSupport, type = 5)
timeFiveSummary
#interquatile range
timeIQR = IQR(timeForLowSupport, type = 5)
timeIQR

# 3c) construction for histogram
timeHist = hist(timeForLowSupport, main = "Steel Structures", xlab = "TIme in hrs", ylab =
"Density")
# stemplot
timeStem = stem(timeForLowSupport, scale = 1)
# boxplot
timeBox = boxplot(timeForLowSupport, main = "Steel structures", ylab = "Time in hrs",
horizontal = TRUE)
# getting the skewness
install.packages("moments")
library(moments)
timeSkewness = skewness(timeForLowSupport)
timeSkewness
```



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The decimal point is 1 digit(s) to the left of the |

 6 | 4
 8 | 671248
10 | 1161345
12 | 59
```