P4:

```
#reading the data from table 8.4 and assigning column names
tab=read.table("T1-10.dat")
head(tab)
```

```
##   V1   V2   V3   V4   V5 V6   V7   V8   V9
## 1  1 2200 51.0 1128 70.9  7 0.25 54.8 1720
## 2  1 2250 51.9 1108 72.1  7 0.25 55.3 1575
## 3  1 1625 49.9 1011 71.6  6 0.15 53.1 1410
## 4  1 4600 53.1  993 68.9  8 0.35 56.4 1595
## 5  1 2150 51.2  996 68.6  7 0.25 55.0 1488
## 6  1 1225 49.2  985 71.4  6 0.15 51.4 1500
```

```
#modifying the data as required
bulls=tab[3:9]
colnames(bulls)=c("YrHgt","FtFrBody","PrctFFB","Frame","BkFat","SaleHt","SaleWt")
head(bulls)
```

```
##   YrHgt FtFrBody PrctFFB Frame BkFat SaleHt SaleWt
## 1  51.0     1128    70.9     7  0.25   54.8   1720
## 2  51.9     1108    72.1     7  0.25   55.3   1575
## 3  49.9     1011    71.6     6  0.15   53.1   1410
## 4  53.1      993    68.9     8  0.35   56.4   1595
## 5  51.2      996    68.6     7  0.25   55.0   1488
## 6  49.2      985    71.4     6  0.15   51.4   1500
```

```
#Principal Component Analysis
#Simple Statistics
means= colMeans(bulls)
SD= apply(bulls,2,sd)
stat= rbind(means,SD)
stat
```

```
##           YrHgt  FtFrBody  PrctFFB     Frame      BkFat    SaleHt    SaleWt
## means 50.522368 995.94737 70.88158 6.3157895 0.19671053 54.126316 1555.2895
## SD     1.731481  92.70568  3.26981 0.9267941 0.08956768  2.004486  129.8101
```

```
#Calculating the covariance matrix,S
S=cov(bulls)
S
```

```
##                YrHgt    FtFrBody     PrctFFB       Frame        BkFat
## YrHgt      2.99802632  100.130526   2.9600175  1.50884211 -0.053392105
## FtFrBody 100.13052632 8594.343860 209.5043509 51.95017544 -1.398175439
## PrctFFB    2.96001754  209.504351  10.6916561  1.45922807 -0.142994737
## Frame      1.50884211   51.950175   1.4592281  0.85894737 -0.021614035
## BkFat     -0.05339211   -1.398175  -0.1429947 -0.02161404  0.008022368
## SaleHt     2.98313684  129.940070   3.4142246  1.48757895 -0.050645614
## SaleWt    82.81077193 6680.308772  83.9254035 44.32070175  2.412964912
##                SaleHt       SaleWt
```

```
## YrHgt      2.98313684    82.810772
## FtFrBody 129.94007018  6680.308772
## PrctFFB    3.41422456    83.925404
## Frame      1.48757895    44.320702
## BkFat     -0.05064561     2.412965
## SaleHt     4.01796491   147.289614
## SaleWt   147.28961404 16850.661754
```

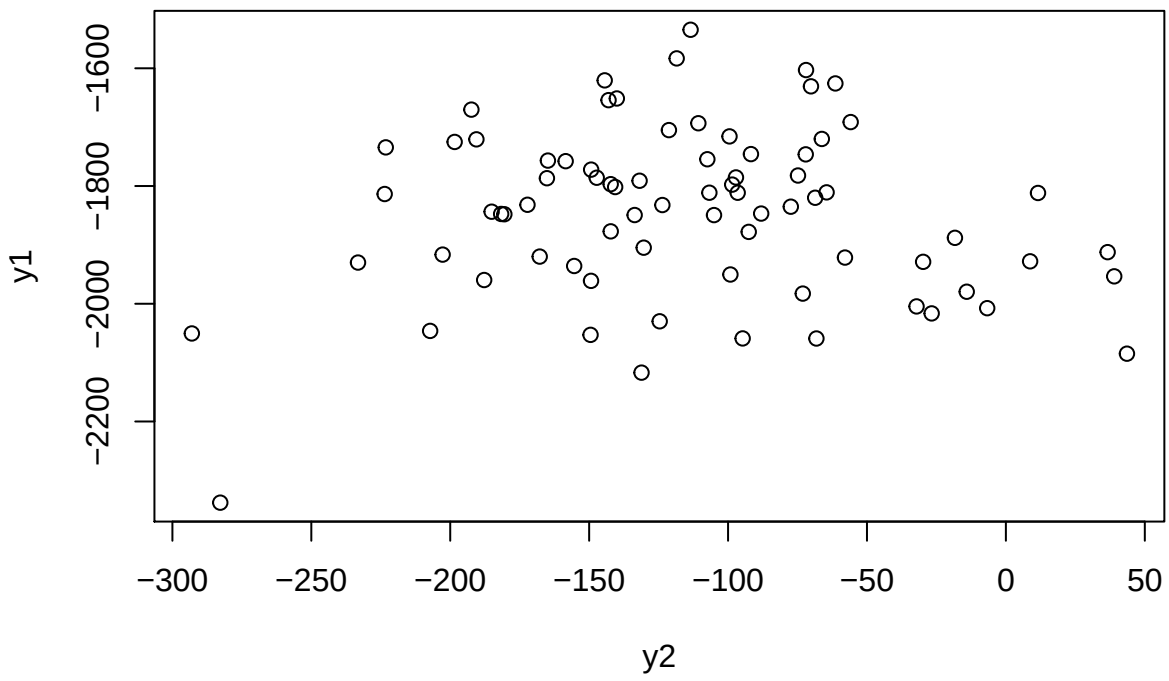
```
#Sample Principal components
e= eigen(S)
e_val= e$values
e_vec= e$vectors
difference= round(-1*diff(e_val),6)
prop_val= e_val/sum(e_val)
total= cumsum(prop_val)

e_value=data.frame(e_val, Difference= c(difference, ''), prop_val, total)
rownames(e_value)= c('PC1', 'PC2','PC3','PC4','PC5','PC6','PC7')
e_value
```

```
##            e_val   Difference     prop_val     total
## PC1 2.057961e+04 15704.937785 8.081979e-01 0.8081979
## PC2 4.874675e+03  4869.245613 1.914371e-01 0.9996351
## PC3 5.429170e+00     2.112861 2.132131e-04 0.9998483
## PC4 3.316308e+00     2.847478 1.302373e-04 0.9999785
## PC5 4.688301e-01     0.394776 1.841179e-05 0.9999969
## PC6 7.405369e-02     0.069534 2.908220e-06 0.9999998
## PC7 4.519442e-03              1.774865e-07 1.0000000
```

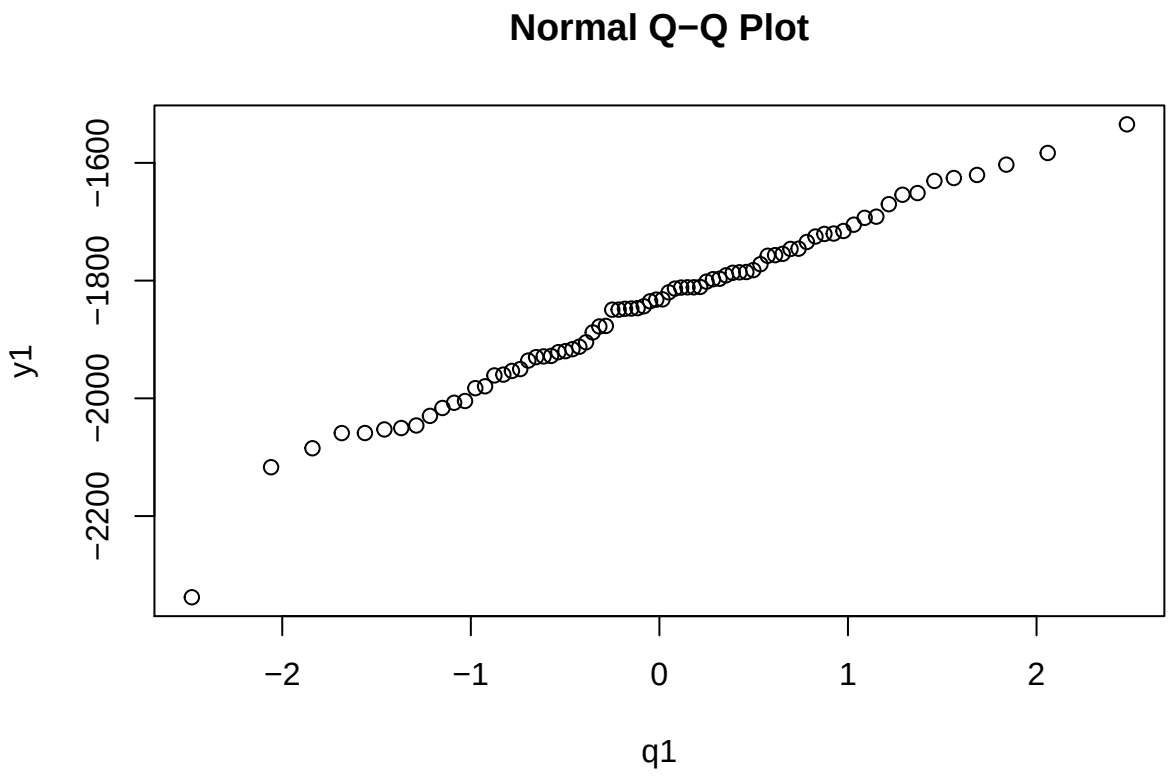
```
e_vector=as.data.frame(e_vec)
colnames(e_vector)=c("PC1","PC2","PC3","PC4","PC5","PC6","PC7")
rownames(e_vector)=c("YrHgt","FtFrBody","PrctFFB","Frame","BkFat","SaleHt","SaleWt")
e_vector
```

```
##                    PC1           PC2          PC3          PC4           PC5
## YrHgt    -5.887328e-03 -0.0096800709  0.286337289 -0.608787152  0.5355689528
## FtFrBody -4.870470e-01 -0.8726966457 -0.034277115  0.003226954  0.0004437402
## PrctFFB  -8.526499e-03 -0.0291964492  0.904388519  0.425174911  0.0083876301
## Frame    -3.111988e-03 -0.0048861100  0.133266834 -0.311194400  0.3905733600
## BkFat    -6.919922e-05  0.0004925452 -0.018864084  0.005278296  0.0119061237
## SaleHt   -9.329509e-03 -0.0085770135  0.284214793 -0.593037047 -0.7485979836
## SaleWt   -8.732589e-01  0.4871927200  0.004846824  0.005597435  0.0026647979
##                    PC6           PC7
## YrHgt    -0.5097273178  0.0245917521
## FtFrBody -0.0004566049 -0.0002530995
## PrctFFB   0.0103890723  0.0142927590
## Frame     0.8552041268 -0.0379840767
## BkFat     0.0437862261  0.9987777777
## SaleHt    0.0823314748  0.0138200628
## SaleWt   -0.0003410092 -0.0002556156
```

```r
bull_mat=as.matrix(bulls)
e_vector_mat=as.matrix(e_vector)
mult=bull_mat%*%e_vector_mat
plot(mult[,2],mult[,1],xlab="y2", ylab="y1")
```




```r
qqnorm(mult[,1],xlab="q1",ylab="y1")
```


Normal Q−Q Plot
y1
−2200
−2000
−1800
−1600
−2
−1
0
1
2
q1