1A.

```
> colMeans(mtcars)
       mpg        cyl       disp         hp       drat         wt       qsec
vs         am       gear       carb
 20.090625   6.187500 230.721875 146.687500   3.596563   3.217250  17.848750
0.437500   0.406250   3.687500   2.812500

> apply(mtcars,2,median)
    mpg     cyl    disp      hp    drat      wt    qsec      vs      am    gear
carb
 19.200   6.000 196.300 123.000   3.695   3.325  17.710   0.000   0.000   4.000
2.000
```

1B.

```
> apply(mtcars,2,mad) (MAD)
        mpg         cyl        disp          hp        drat          wt
qsec          vs          am        gear
  5.4114900   2.9652000 140.4763500  77.0952000   0.7042350   0.7672455
1.4158830   0.0000000   0.0000000   1.4826000
       carb
  1.4826000

> apply(mtcars, 2, function(x) mean(abs(x - mean(x)))) (AAD)
        mpg         cyl        disp          hp        drat          wt
qsec          vs          am        gear
  4.7144531   1.5859375 108.7857422  56.4804688   0.4532422   0.7301875
1.3761719   0.4921875   0.4824219   0.6445312
       carb
  1.3007812
```

```
1C.
> meanMpg = sum(mtcars$mpg) / length(mtcars$mpg)
>
> varMpg = sum((mtcars$mpg - meanMpg)^2) / (length(mtcars$mpg) - 1)
> sdMpg = sqrt(varMpg)
>
> varMpg
[1] 36.3241
> var(mtcars$mpg)
[1] 36.3241
>
> sdMpg
[1] 6.026948
> sd(mtcars$mpg
```

1D.

```
> skew <- (sum((mtcars$mpg - mean(mtcars$mpg))^3) / (length(mtcars$mpg) *
sd(mtcars$mpg)^3))
```

```
>
> kurtosis <- (sum((mtcars$mpg - mean(mtcars$mpg))^4) / (length(mtcars$mpg) *
sd(mtcars$mpg)^4)) - 3
>
>
> skew
[1] 0.610655
> skew(mtcars$mpg)
[1] 0.610655
>
> kurtosis
[1] -0.372766
> kurtosi(mtcars$mpg)
[1] -0.372766
```

1E.

```
> apply(mtcars,2,kurtosi)
        mpg         cyl        disp          hp        drat          wt
qsec          vs          am        gear
-0.37276603 -1.76211977 -1.20721195 -0.13555112 -0.71470062 -0.02271075
0.33511422 -2.00193762 -1.92474143 -1.06975068
       carb
 1.25704307
> apply(mtcars,2,skew)
       mpg        cyl       disp         hp       drat         wt       qsec
vs         am       gear       carb
 0.6106550 -0.1746119  0.3816570  0.7260237  0.2659039  0.4231465  0.3690453
0.2402577  0.3640159  0.5288545  1.0508738
```

1F.

```
> pearsonWTMPG <- sum((mtcars$wt - mean(mtcars$wt)) * (mtcars$mpg -
mean(mtcars$mpg))) / (sqrt(sum((mtcars$wt - mean(mtcars$wt))^2)) *
sqrt(sum((mtcars$mpg - mean(mtcars$mpg))^2)))

> pearsonWTMPG = sum((mtcars$wt - mean(mtcars$wt)) * (mtcars$mpg -
mean(mtcars$mpg))) / (sqrt(sum((mtcars$wt - mean(mtcars$wt))^2)) *
sqrt(sum((mtcars$mpg - mean(mtcars$mpg))^2)))

> spearmanWTMPG = 1 - (6 * sum((rank(mtcars$wt) - rank(mtcars$mpg))^2) /
(length(mtcars$wt) * (length(mtcars$wt)^2 - 1)))
>
> pearsonCYLMPG = sum((mtcars$cyl - mean(mtcars$cyl)) * (mtcars$mpg -
mean(mtcars$mpg))) / (sqrt(sum((mtcars$cyl - mean(mtcars$cyl))^2)) *
sqrt(sum((mtcars$mpg - mean(mtcars$mpg))^2)))

> spearmanCYLMPG = 1 - (6 * sum((rank(mtcars$cyl) - rank(mtcars$mpg))^2) /
(length(mtcars$cyl) * (length(mtcars$cyl)^2 - 1)))
>
```

```
> pearsonGEARWT = sum((mtcars$gear - mean(mtcars$gear)) * (mtcars$wt -
mean(mtcars$wt))) / (sqrt(sum((mtcars$gear - mean(mtcars$gear))^2)) *
sqrt(sum((mtcars$wt - mean(mtcars$wt))^2)))

> spearmanGEARWT = 1 - (6 * sum((rank(mtcars$gear) - rank(mtcars$wt))^2) /
(length(mtcars$gear) * (length(mtcars$gear)^2 - 1)))
>
> pearsonWTMPG
[1] -0.8676594
> spearmanWTMPG
[1] -0.8843475
>
> pearsonCYLMPG
[1] -0.852162
> spearmanCYLMPG
[1] -0.7794172
>
> pearsonGEARWT
[1] -0.583287
> spearmanGEARWT
[1] -0.5400477
```

2A.

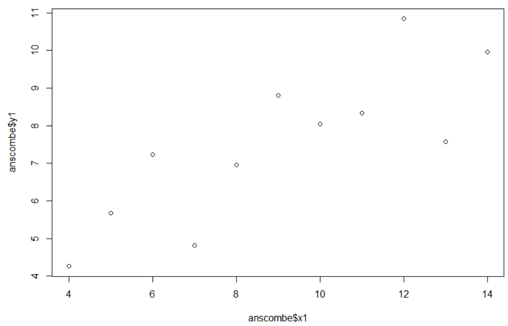
```
> cor(x = anscombe$x1, y = anscombe$y1, method = "pearson")
[1] 0.8164205
> cor(x = anscombe$x1, y = anscombe$y1, method = "pearson")
[1] 0.8164205
> cor(x = anscombe$x1, y = anscombe$y1, method = "spearman")
[1] 0.8181818
> cor(x = anscombe$x2, y = anscombe$y2, method = "pearson")
[1] 0.8162365
> cor(x = anscombe$x2, y = anscombe$y2, method = "spearman")
[1] 0.6909091
> cor(x = anscombe$x3, y = anscombe$y3, method = "pearson")
[1] 0.8162867
> cor(x = anscombe$x3, y = anscombe$y3, method = "spearman")
[1] 0.9909091
> cor(x = anscombe$x4, y = anscombe$y4, method = "pearson")
[1] 0.8165214
> cor(x = anscombe$x4, y = anscombe$y4, method = "spearman")
[1] 0.5
```

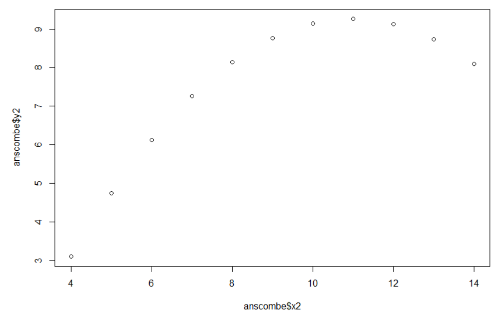
They are all around 0.8ish

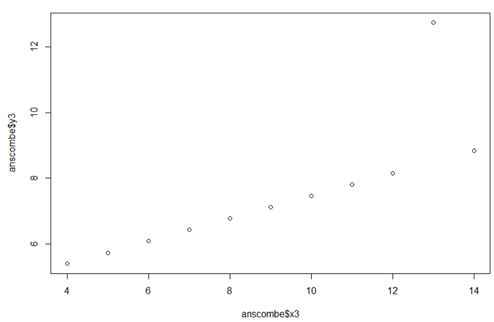
2B.

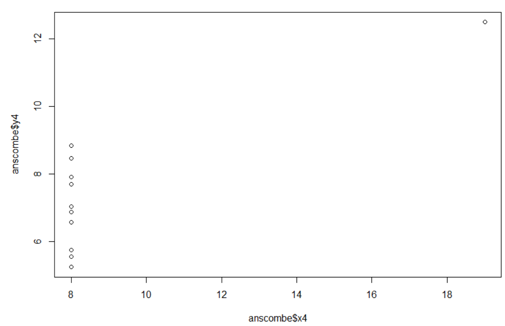
```
> plot(anscombe$x1,anscombe$y1)
> plot(anscombe$x2,anscombe$y2)
> plot(anscombe$x3,anscombe$y3)
```

```
> plot(anscombe$x4,anscombe$y4)
```









3A.

Assert that we have X and Y for every sample (S) and a constant C, Y_S is equal to the C times X_S.

so Y_S = C*X_S for all samples.

pearson formula is r = cov(X, Y) / (sd(X) * sd(Y))

so if we do the covariance we have cov(X, Y) = E[(X - E[X])(Y - E[Y])]

but Since Y_S = C*X_S for all samples, we have:

E[Y] = E[cX] = cE[X]

so we can simplify it to C*var(X)

the same thing applies to the standard deviation : sd(X) = sqrt(var(X))

so we can write it as r = cov(X, Y) / (sd(X) * sd(Y)) which simplfies to 1.

so no matter the value of the constant, Y_S = C*X_S for all samples, this is likely because Y is a linear function of X with a positive slope. The variables have a near perfect positive linear slope.

(i'm assuming this is what i'm supposed to do.)

3B.

Assert X and Y and for every sample S, Y_S is equal to some constant C. So we have Y_S = C for all samples (S).

Pearson formula = r = cov(X, Y) / (sd(X) * sd(Y))

first calculate the covar of X and Y. covariance is: cov(X, Y) = E[(X - E[X])(Y - E[Y])]

where E[X] and E[Y] are the means of X and Y.

Since Y_S = C for all S, we have:

E[Y] = E[c] = C

So the covariance can be simplified to: 0

Therefore, the Pearson correlation coefficient can be written as:

r = cov(X, Y) / (sd(X) * sd(Y)) or 0

So the Pearson correlation coefficient between X and Y is equal to 0 when Y is a constant. This is because, the two variables do not have a linear relationship.

4.

Using only the mean or median to describe a set is often insufficient because it only provides a single measure of central tendency and does not really capture the full picture. It also doesn't account for outliers correctly.

5.

The opposite applies here, using the mean and/or standard deviation if often sensitive to outliers or extremes. Also it's not very good for abnormal distributions of data.