STATISTICS 3N03/3J04 – TEST #3A SOLUTIONS

Question 1a

Paired data *t*-test is the correct parametric analysis.
[11 marks if all of the following is given; maximum 8 marks for a wrong analysis.]

Assumptions: Normality (can't test with such a small sample but it does not look good on a stem and leaf plot or dot plot); independence (can't test: sample is small and the observations are not in any particular order).

Conclusion: There is some evidence from these data (P = 0.078) that the mean noise level is different in acceleration and deceleration lanes in Bangkok. Note: using the textbook tables we get 2-sided 0.1 > P > 0.05.

```
> bangkokA
    acc  dec diff
1  78.1 78.6 -0.5
2  78.1 80.0 -1.9
3  79.6 79.3  0.3
4  81.0 79.1  1.9
5  88.7 78.2 10.5
6  88.1 78.0 10.1
7  78.6 78.6  0.0
8  78.5 78.8 -0.3
9  88.4 78.0 10.4
10 79.6 78.4  1.2
> stem(bangkokA$diff)

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

  -0 | 210
   0 | 0012
   0 |
   1 | 001

> t.test(bangkokA$acc,bangkokA$dec,pair=T)

      Paired t-test

data:  bangkokA$acc and bangkokA$dec
t = 1.9872, df = 9, p-value = 0.07815
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.4386036  6.7786036
sample estimates:
mean of the differences
                   3.17
```

Sign test is the correct nonparametric analysis
[5 marks if all of the following is given.]

Conclusion: Out of 9 non-zero differences, 3 were negative, so a 2-sided P-value is twice the left tail of Bin(9, 0.5). There is no evidence from these data (P = 0.51) that the mean noise level is different in acceleration and deceleration lanes in Bangkok.

The *t*-test is more powerful than the sign test. The sign test is more robust than the *t*-test because it does not assume normality.

```
> 2*pbinom(sum(bangkokA$diff<0), sum(bangkokA$diff!=0), 0.5)
```

```
[1] 0.5078125
```

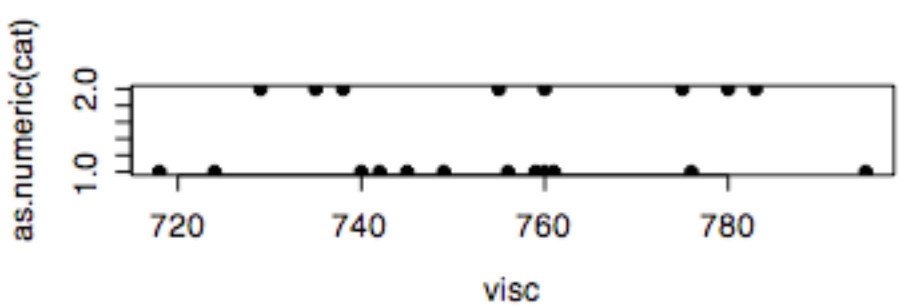
Question 1b

Independent-sample *t*-test is the correct parametric analysis.
[16 marks if all of the following is given, including the F-test; maximum 8 marks for a wrong analysis.]

Assumptions: Normality (can't test with such a small sample but it looks OK on comparative stem and leaf or dot plots); independence within and between samples (can't test: samples are small and the observations are not in any particular order); homoscedasticity (accepted by the *F*-test below).

Conclusion: There is no evidence from these data (P = 0.63) that the mean viscosity is different after changing the catalyst. Note: using the textbook tables we get 2-sided 0.8 > P > 0.5.

```
> catalystA
   visc cat
1   724   A
2   718   A
3   776   A
4   760   A
5   745   A
6   759   A
7   795   A
8   756   A
9   742   A
10  740   A
11  761   A
12  749   A
16  735   B
17  775   B
18  729   B
19  755   B
20  783   B
21  760   B
22  738   B
23  780   B
```




```
> t.test(visc~cat,catalystA,var.equal=T)

      Two Sample t-test

data:  visc by cat
t = -0.4965, df = 18, p-value = 0.6256
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -25.06809  15.48476
sample estimates:
mean in group A mean in group B
       752.0833        756.8750
```

Two-sided *F*-test is the correct test for homoscedasticity.

Assumptions: Same as for the *t*-test. Normality (can't test with such a small sample but it looks OK on comparative stem and leaf or dot plots); independence within and between samples (can't test: samples are small and the observations are not in any particular order).

Conclusion: $F_0 = 1.0217$, so there is no evidence from these data ($P = 0.92$) that the variance in viscosity is different after changing the catalyst. Note: using the textbook tables we get 2-sided $P > 0.5$.

```
> catvar<-sapply(split(catalystA$visc,catalystA$cat),var)
> catvar
       A        B
443.3561 452.9821
> sqrt(catvar)
       A        B
21.05602 21.28338
> (11*catvar[1]+7*catvar[2])/18
       A
447.0995
> sqrt((11*catvar[1]+7*catvar[2])/18)
       A
21.14473
> catvar[2]/catvar[1]
       B
1.021712
> 2*(1-pf(catvar[2]/catvar[1],7,14))
        B
0.9157905
```

Question 2
[5 marks.]

Here, $n_1 = 12$, $n_2 = 8$, $\alpha = 0.05$, $\delta = .2$, and we use $\sigma^2 = s_p^2 = 447.0995$. From tables, $z_{0.025} = 1.960$. We find that the chance of a Type II error is 82%.

```
> s2p<-(11*catvar[1]+7*catvar[2])/18
> s2p
       A
447.0995
> 10/sqrt(s2p*(1/12+1/8))
       A
1.036140
> qnorm(0.975)-10/sqrt(s2p*(1/12+1/8))
        A
0.9238238
> -qnorm(0.975)-10/sqrt(s2p*(1/12+1/8))
        A
-2.996104
> pnorm(qnorm(0.975)-10/sqrt(s2p*(1/12+1/8)))+pnorm(-qnorm(0.975)-
10/sqrt(s2p*(1/12+1/8)))
        A
0.8235782
```

Question 2
[3 marks.]

William Sealey Gosset + 3 interesting facts.