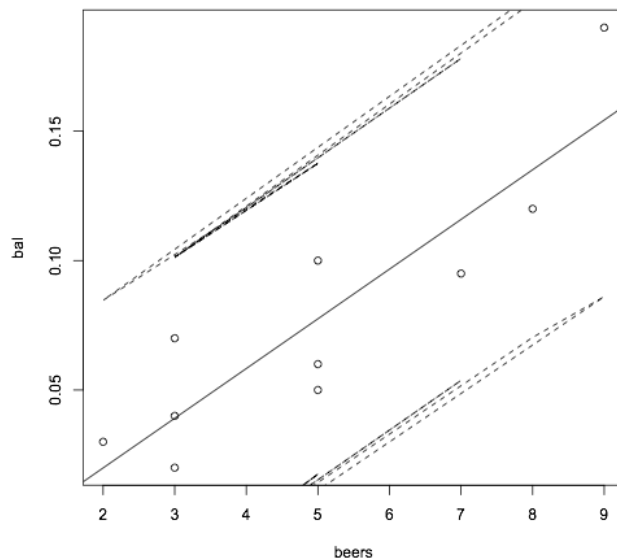Question 1

Part 1

```
> beers = c(5,2,9,8,3,7,3,5,3,5)
> bal = c(0.1,0.03,0.19,0.12,0.04,0.095,0.07,0.06,0.02,0.05)
> res = lm(bal~beers)
> plot(bal~beers)
> abline(res)
> pred = predict(res,int="prediction")
```

Warning message:

In predict.lm(res, int = "prediction") :

predictions on current data refer to _future_ responses

```
> lines(beers,pred[,2], lty=2) # lower curve
> lines(beers,pred[,3], lty=2) # upper curve
```

Part 2
> summary(res)

Call:
lm(formula = bal ~ beers)

Residuals:
   Min   1Q Median   3Q   Max
-0.0275 -0.0187 -0.0071 0.0194 0.0357

Coefficients:
           Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.018500   0.019230 -0.962 0.364200
beers   0.019200   0.003511   5.469 0.000595 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02483 on 8 degrees of freedom
Multiple R-squared: 0.789,   Adjusted R-squared: 0.7626
F-statistic: 29.91 on 1 and 8 DF, p-value: 0.0005953

```
> betahat1 = -0.019200 # read from summary
> SE = 0.003511 # read from summary
> tstar = qt(1-0.05/2, df = 2)
> c(betahat1 - tstar*SE, betahat1 + tstar*SE)
[1] -0.034306614 -0.004093386
```
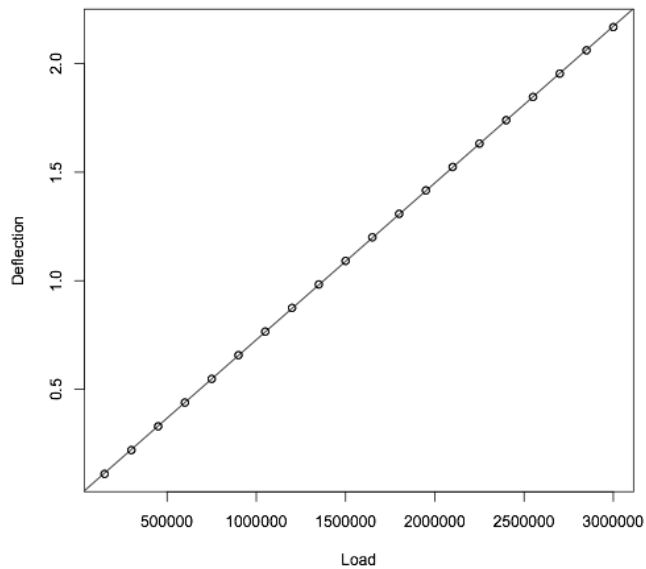
Question 2
```
> attach(deflection)
> res = lm(Deflection~Load)
> plot(Deflection~Load)
> abline(res)
```
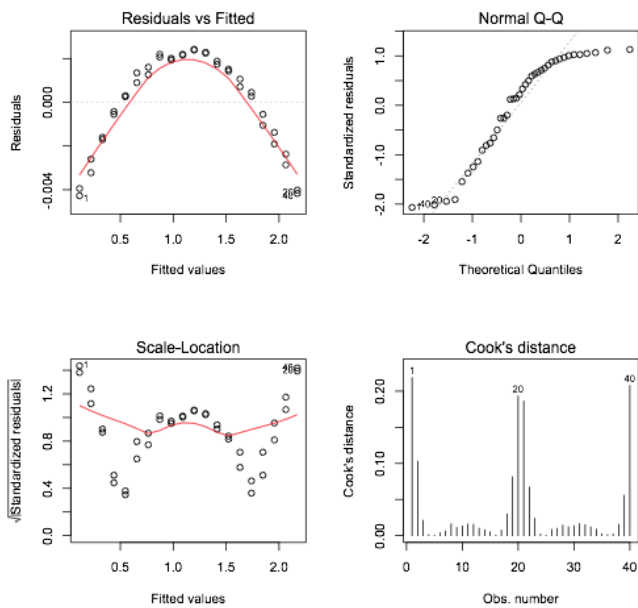
Part 3

The residual connects every dot directly and we conclude they are normally distributed.

The Residuals vs fitted plot show that the error does not have common variance due to it's non horizontal nature, and that we have a linear relationship

The QQ plot shows that the residuals are rather normally distributed

The Scale-location plot shows that the spread gets larger towards to the extremities of the residuals, but in a continuous fashion

Cook's distance is showing that the residuals are being heavily influenced by a few outliers

Part 4.
> quad = lm(formula = Deflection ~ 0 + (Load-1) + I(Load^2)-2)

Part 5.
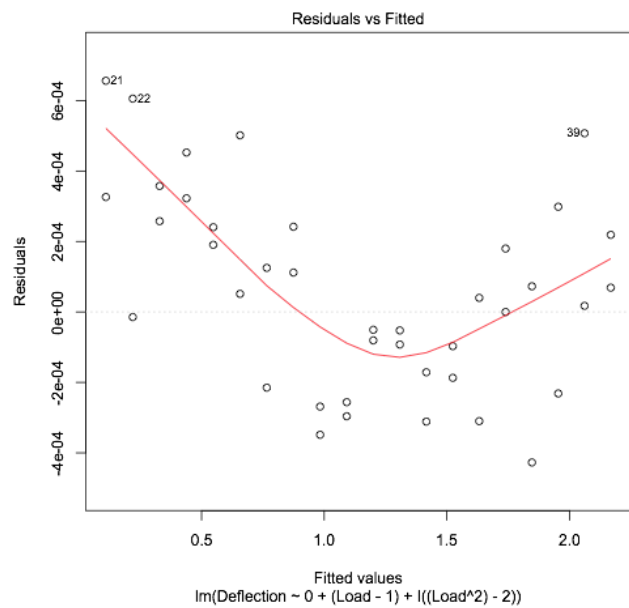
It fits better than the linear equation, and has a more horizontal line

Question 3
Part 1.
> attach(galton)
> res = lm(child~parent)

Part 2.

Question 4

res = lm(weight~0+(1-age)+(2-height)+(3-I(height^2))+(4-I(height^3))+(5-I(height^4)))
model1 = lm(weight~0+(1-age)+(2-height)+(3-I(height^2)))

Model2 = lm(weight~0+(1-age)+(2-height)+(4-I(height^3)))

Model3 = lm(weight~0+(1-age)+(2-height)+(5-I(height^4)))
> anova(res, Model1, Model2, Model3)

Question 5
> res =
lm(body.fat~age+weight+height+BMI+neck+chest+abdomen+hip+thigh+knee+ankle+bicep+forearm+wrist)
> stepAIC(res)
Start: AIC=712.72
body.fat ~ age + weight + height + BMI + neck + chest + abdomen +
    hip + thigh + knee + ankle + bicep + forearm + wrist

```
           Df Sum of Sq    RSS    AIC
- knee      1     0.00 3784.4 710.72
- BMI       1     0.77 3785.1 710.77
- chest     1     1.59 3786.0 710.83
- height    1     4.20 3788.6 711.00
- ankle     1     9.16 3793.5 711.33
- bicep     1    13.75 3798.1 711.63
<none>              3784.4 712.72
- hip       1    35.04 3819.4 713.04
- weight    1    42.41 3826.8 713.53
- thigh     1    44.92 3829.3 713.69
- age       1    57.29 3841.7 714.51
- neck      1    66.28 3850.6 715.10
- forearm   1    86.26 3870.6 716.40
- wrist     1   141.64 3926.0 719.98
- abdomen   1  1689.43 5473.8 803.73
```

Step: AIC=710.72
body.fat ~ age + weight + height + BMI + neck + chest + abdomen +
    hip + thigh + ankle + bicep + forearm + wrist

```
           Df Sum of Sq    RSS    AIC
- BMI       1     0.81 3785.2 708.77
- chest     1     1.59 3786.0 708.83
- height    1     4.21 3788.6 709.00
- ankle     1     9.49 3793.9 709.35
- bicep     1    13.79 3798.2 709.64
<none>              3784.4 710.72
- hip       1    35.25 3819.6 711.06
- weight    1    45.74 3830.1 711.75
- thigh     1    49.30 3833.7 711.98
```

```
- age      1     60.80 3845.2 712.74
- neck     1     67.09 3851.5 713.15
- forearm  1     86.97 3871.3 714.45
- wrist    1    142.56 3926.9 718.04
- abdomen  1   1689.58 5473.9 801.74

Step:  AIC=708.77
body.fat ~ age + weight + height + neck + chest + abdomen + hip +
    thigh + ankle + bicep + forearm + wrist

          Df Sum of Sq    RSS    AIC
- chest    1      1.02 3786.2 706.84
- height   1      8.56 3793.7 707.34
- ankle    1     10.17 3795.4 707.45
- bicep    1     14.99 3800.2 707.77
<none>               3785.2 708.77
- hip      1     34.44 3819.6 709.06
- weight   1     45.36 3830.5 709.78
- thigh    1     50.96 3836.1 710.14
- age      1     60.12 3845.3 710.74
- neck     1     66.66 3851.8 711.17
- forearm  1     86.98 3872.2 712.50
- wrist    1    142.38 3927.6 716.08
- abdomen  1   1954.93 5740.1 811.70

Step:  AIC=706.84
body.fat ~ age + weight + height + neck + abdomen + hip + thigh +
    ankle + bicep + forearm + wrist

          Df Sum of Sq    RSS    AIC
- height   1      7.67 3793.9 705.35
- ankle    1     10.45 3796.6 705.54
- bicep    1     14.42 3800.6 705.80
<none>               3786.2 706.84
- hip      1     33.43 3819.6 707.06
- thigh    1     55.76 3842.0 708.53
- age      1     59.93 3846.1 708.80
- weight   1     60.73 3846.9 708.85
- neck     1     67.57 3853.8 709.30
- forearm  1     85.96 3872.2 710.50
- wrist    1    141.88 3928.1 714.11
- abdomen  1   2478.69 6264.9 831.75
```

Step: AIC=705.35
body.fat ~ age + weight + neck + abdomen + hip + thigh + ankle +
    bicep + forearm + wrist

	Df	Sum of Sq	RSS	AIC
- ankle	1	11.20	3805.1	704.09
- bicep	1	16.21	3810.1	704.43
- hip	1	28.16	3822.0	705.22
<none>			3793.9	705.35
- thigh	1	63.66	3857.5	707.55
- neck	1	65.45	3859.3	707.66
- age	1	66.23	3860.1	707.71
- forearm	1	88.14	3882.0	709.14
- weight	1	102.94	3896.8	710.10
- wrist	1	151.52	3945.4	713.22
- abdomen	1	2737.19	6531.1	840.23

Step: AIC=704.09
body.fat ~ age + weight + neck + abdomen + hip + thigh + bicep +
    forearm + wrist

	Df	Sum of Sq	RSS	AIC
- bicep	1	14.91	3820.0	703.08
- hip	1	29.32	3834.4	704.03
<none>			3805.1	704.09
- age	1	63.17	3868.2	706.24
- thigh	1	66.76	3871.8	706.48
- neck	1	74.16	3879.2	706.96
- forearm	1	87.57	3892.6	707.83
- weight	1	92.42	3897.5	708.14
- wrist	1	140.36	3945.4	711.22
- abdomen	1	2740.72	6545.8	838.80

Step: AIC=703.08
body.fat ~ age + weight + neck + abdomen + hip + thigh + forearm +
    wrist

	Df	Sum of Sq	RSS	AIC
<none>			3820.0	703.08
- hip	1	33.23	3853.2	703.26
- neck	1	67.79	3887.8	705.51
- age	1	67.88	3887.9	705.52
- weight	1	81.50	3901.5	706.40

```
- thigh    1    90.34 3910.3 706.97
- forearm  1    122.99 3943.0 709.07
- wrist    1    139.46 3959.4 710.12
- abdomen  1   2726.49 6546.5 836.83
```

Call:
lm(formula = body.fat ~ age + weight + neck + abdomen + hip +
    thigh + forearm + wrist)

Coefficients:
```
(Intercept)        age      weight       neck      abdomen        hip
 -20.06213     0.05922    -0.08414    -0.43189      0.87721    -0.18641
      thigh     forearm       wrist
    0.28644     0.48255    -1.40487
```