5.31

a.

Estimate the equation $TIME = \beta_1 + \beta_2 DEPART + \beta_3 REDS + \beta_4 TRAINS + e$ **Report the results and interpret each of the coefficient estimates, including the intercept.**

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  20.8701     1.6758  12.454  < 2e-16 ***
depart        0.3681     0.0351  10.487  < 2e-16 ***
reds          1.5219     0.1850   8.225 1.15e-14 ***
trains        3.0237     0.6340   4.769 3.18e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.299 on 245 degrees of freedom
Multiple R-squared:  0.5346,	Adjusted R-squared:  0.5289 
F-statistic: 93.79 on 3 and 245 DF,  p-value: < 2.2e-16
```

Beta 1: holding other variable the same, if he departs from 6:30 and encounters zero reds and waits zero train, the time he drives to work is 20.87 minute.

Beta 2: holding other variable the same, for every minute later that Bill departs after 6:30 AM, his commute time increases by approximately 0.3681 minutes.

Beta 3: holding other variable the same, each additional red light encountered adds about 1.5219 minutes to the total commute time.

Beta 4: holding other variable the same, each additional train that Bill has to wait for adds approximately 3.02 minutes to the commute.

b.

Find 95% interval estimates for each of the coefficients. Have you obtained precise estimates of each of the coefficients?

```
> confint(model, level = 0.95)
                 2.5 %    97.5 %
(Intercept) 17.5694018 24.170871
depart       0.2989851  0.437265
reds         1.1574748  1.886411
trains       1.7748867  4.272505
```

Because the p-value all less than 0.05, I think the coefficient estimated precisely.

c.

Using a 5% significance level, test the null hypothesis that Bill's expected delay from each red light is 2 minutes or more against the alternative that it is less than 2 minutes.

H0: beta 3 >= 2 against H1: beta 3 < 2

t-stat = (1.5219-2)/0.1850 = - 2.583562

the critical value is -1.645, -2.583562<-1.645, so we reject H0, and conclude that Bill's expected delay from each red light is less than 2 minutes.

d.

Using a 10% significance level, test the null hypothesis that the expected delay from each train is 3 minutes against the alternative that it is not 3 minutes.

H0: beta 4 = 3 against H1: beta 4 not the same 3

t-stat = (3.0237-3)/0.6340 = 0.03737444

the critical value is 1.645, 0.03737444<1.645, so we do not reject h0, can not conclude that the expected delay from each train is not 3 minutes.

e.

Using a 5% significance level, test the null hypothesis that Bill can expect a trip to be at least 10 minutes longer if he leaves at 7:30 AM instead of 7:00 AM, against the alternative that it will not be 10 minutes longer.

H0: beta 1 > 1/3 against H1: beta 1 <= 1/3

t-stat = (0.3681-1/3)/0.0351 = 0.9911646

the critical value is 1.645, 0.9911646<1.645, so we do not reject h0, can not conclude that Bill can expect a trip to be 10 minutes longer, if he leaves at 7:30 AM instead of 7:00 AM.

f.

Using a 5% significance level, test the null hypothesis that the expected delay from a train is at least three times greater than the expected delay from a red light against the alternative that it is less than three times greater.

H0: beta 4 >= 3*beta 3 against H1: beta 4 < 3*beta 3

t-stat = (3.0237-3*1.5219)/ 0.844992 = -1.825027

the critical value is - 1.645, -1.825027<-1.645, so we reject h0, conclude that beta 4 < 3*beta 3.

g.

Suppose that Bill encounters six red lights and one train. Using a 5% significance level, test the null hypothesis that leaving Carnegie at 7:00 AM is early enough to get him to the university on or before 7:45 AM against the alternative that it is not.

H0: beta 1+30beta 2 +6beta 3 +beta 4 <= 45 against H1: h0 is wrong

t-stat = -1.725964

the critical value is - 1.645, -1.725964<1.645, so we do not reject h0, can not conclude that it is greater than 45 minute.

h.

Suppose that, in part (g), it is imperative that Bill is not late for his 7:45 AM meeting. Have the null and alternative hypotheses been set up correctly? What happens if these hypotheses are reversed.

he need to show up at 7:45 in the meeting, we do not reject h0 do not mean that he really can show up in the meeting 45 minute later. If we reverse the hypotheses -1.725964<-1.645, we can reject h0, and conclude that he drives less than 45 minute and can show up in the meeting on time.