Untitled

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4.(a)

```
library(readxl)
chem <- read_excel("clathrates.xls")
fit = lm(chem$y~chem$x1 + chem$x2, chem)
summary(fit)
```

```
##
## Call:
## lm(formula = chem$y ~ chem$x1 + chem$x2, data = chem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.7716 -4.1656  0.0802  3.8323  8.3349
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1.109e+01  1.669e+00   6.642 1.48e-07 ***
## chem$x1     3.501e+02  3.968e+01   8.823 3.38e-10 ***
## chem$x2     1.089e-01  9.983e-03  10.912 1.74e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.782 on 33 degrees of freedom
## Multiple R-squared:  0.8415, Adjusted R-squared:  0.8319
## F-statistic:  87.6 on 2 and 33 DF,  p-value: 6.316e-14
```

So $y = 11.0870 + 350.1192x_1 + 0.1089x_2$

(b) When there are no surfactant, at the beginning of clathrate formation, 11.087% clathrate has formed. When the amount of surfactant increased 0.01%, there are 3.5% new formed clathrate compare to the same amount of surfactant at same time. In 1 mintue, there are 0.1089% new formed clathrate when the amount of surfactant does not change.

(c) $H_0 : \beta_1 = 0$ vs. $H_a : \beta_1 \neq 0$ form summary(fit), $se(\beta_1) = 39.68$. So $t = \frac{\hat{\beta}_1 - 0}{se(\beta_1)}$

```
t = as.numeric(fit$coefficients[2] / 39.68)
tdist = qt(0.975, nrow(chem) - 3)
t
```

```
## [1] 8.82357
```

```
tdist
```

```
## [1] 2.034515
```

Since $|t| > t_{0.975,33}$ we reject H_0. So there is a linear relationship between clathrate formation and amount of surfactant.

$H_0 : \beta_2 = 0$ vs. $H_a : \beta_2 \neq 0$ form summary(fit), $se(\beta_2) = 9.983 * 10^{-3}$. So $t = \frac{\hat{\beta}_2 - 0}{se(\beta_2)}$

```r
t = as.numeric(fit$coefficients[3] / 0.009983)
tdist = qt(0.975, nrow(chem) - 3)
t
```

```
## [1] 10.91199
```

```r
tdist
```

```
## [1] 2.034515
```

Since $|t| > t_{0.975,33}$ we reject H_0. There is a linear relationship between clathrate formation and time.