

# Quiz 1 Practice Questions

You can expect about half this number of questions on Quiz #1

## Conceptual Exercises

In Sleuth (Chap 9, p. 261) 1, 2, 3, 4, 5, 8

## Question One

The weekly gas consumption (in 1000 cubic feet) and the average outside temperature (in degrees Celsius) was recorded for 26 weeks before and 30 weeks after cavity-wall insulation had been installed in a house in south-east England in the 1960s. The house thermostat was set at 20C throughout.

The following model is proposed

$$\mu\{Gas\ Consumption|Before, Temperature\} = \beta_0 + \beta_1 before + \beta_2 Temperature$$

where *before* is an indicator variable for before insulation was installed.

1. What is the model for the mean gas consumption for a week **before** insulation was installed, in terms of the parameters?
2. What is the model for the mean gas consumption for a week **after** insulation was installed, in terms of the parameters?
3. Which parameter describes the change in mean gas consumption before and after insulation installation, holding temperature constant?

## Question Two

FEV (forced expiratory volume) is an index of pulmonary function that measures the volume of air expelled after one second of constant effort.

It is of interest whether being a smoker affects FEV, but it is also known the gender and height also affect FEV.

The following model is found to fit well:

$$\mu\{FEV|Height, Female, Smoker\} = \beta_0 + \beta_1 height + \beta_2 smokerCurrent + \beta_3 female + \beta_4 smokerCurrent \times female$$

where *height* is height in inches, *smokerCurrent* is an indicator variable for being a currently being a smoker, and *female* is an indicator for being female.

1. What is the effect of *height*, in terms of the parameters?
2. What is the difference in mean FEV between a **female smoker** and a **female non-smoker** of the same height, in terms of the parameters?

3. The model fitted to 654 people and the results are shown below. Using the fitted model, what is the fitted mean FEV for a **male non-smoker** 60 inches tall?

Call:

```
lm(formula = FEV ~ Height + Sex + Smoker + Sex:Smoker, data = fev)
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-1.6771 -0.2496  0.0026  0.2424  2.0904
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-5.2284	0.1924	-27.17	<2e-16 ***
Height	0.1294	0.0031	41.72	<2e-16 ***
SexFemale	-0.1074	0.0356	-3.01	0.0027 **
SmokerCurrent	0.1626	0.0893	1.82	0.0691 .
SexFemale:SmokerCurrent	-0.2160	0.1135	-1.90	0.0575 .

---

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

Residual standard error: 0.426 on 649 degrees of freedom

Multiple R-squared: 0.76, Adjusted R-squared: 0.759

F-statistic: 514 on 4 and 649 DF, p-value: <2e-16

### Question Three

A researcher is interested in the relationship between weight and body length for three species of rats: black rat (*Rattus rattus*), brown rat (*Rattus norvegicus*) and the Maori rat (*Rattus exulans Peale*).

Let *brown* be an indicator variable for a brown rat, *black* be an indicator variable for a black rat, and *maori* be an indicator for a Maori rat.

1. Write down a model where mean body weight depends linearly on body length with possibly different slopes and intercepts for each species of rat.
2. Write down a model where mean body weight depends linearly on body length with the same slope and intercept for all species of rat.
3. How many extra parameters are in model 1?

### Question Four

Consider the following regression model

$$\mu\{Y|X, Z\} = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 X \times Z$$

where  $X$  is a continuous variable and  $Z$  is also a continuous variable.

1. What is the effect of  $X$ ?

## Question Five

The following model is estimated in R

$$\mu\{\text{weight}|\text{height}, \text{waist}, \text{male}\} = \beta_0 + \beta_1\text{male} + \beta_2\text{height} + \beta_3\text{waist} + \beta_4\text{male} \times \text{waist}$$

where *male* is an indicator variable that the subject is male, *height* is the height of the subject in cm, and *waist* is their waist girth in centimeters, measured at the narrowest part of torso.

1. Which parameter captures the difference in the mean weight for a male compared to a female of the same height and waist?
2. Which parameter captures the difference in the relationship between mean weight and waist for a male compared to a female, keeping height constant?
3. The results from the fit are shown below. Interpret the estimate for  $\beta_2$ .

```
##
## Call:
## lm(formula = weight ~ male + waist + height + waist:male, data = bdims)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -14.714  -2.848  -0.161   2.768  20.115
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -96.5079     5.1890  -18.60  <2e-16 ***
## male          8.3477     3.7111   2.25  0.0249 *
## waist        1.0253     0.0361  28.36  <2e-16 ***
## height       0.5188     0.0289  17.92  <2e-16 ***
## male:waist  -0.1489     0.0481  -3.09  0.0021 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.39 on 502 degrees of freedom
## Multiple R-squared:  0.892, Adjusted R-squared:  0.892
## F-statistic: 1.04e+03 on 4 and 502 DF,  p-value: <2e-16
```

## Question Six

Consider the following model of total length to head length for possums in Australia:

$$\mu\{\text{totalL}|\text{headL}, \text{sex}\} = \beta_0 + \beta_1\text{headL} + \beta_2\text{sexm}$$

where *totalL* is the total length of a possum in mm, *headL* is the length of its head in mm, and *sexm* is an indicator variable for the possum being male.

1. Write down the model for the mean total length as a function of the head length for a **female possum**.

2. Write down the model for the mean total length as a function of the head length for a **male possum**.
3. What kind of model is this? (i.e. equal lines, parallel lines, separate lines)
4. The model is fit in R and the results are shown below, write a sentence interpreting  $\beta_2$ .

```
##  
## Call:  
## lm(formula = totalL ~ headL + sex, data = possum, na.action = na.exclude)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max   
## -6.469 -2.065  0.583  1.777  8.447   
##  
## Coefficients:  
##              Estimate Std. Error t value Pr(>|t|)      
## (Intercept)   8.2610     7.6149   1.08 0.28057      
## headL         0.8643     0.0825  10.48 < 2e-16 ***  
## sexm         -2.0646     0.5957  -3.47 0.00078 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 2.97 on 101 degrees of freedom  
## Multiple R-squared:  0.533, Adjusted R-squared:  0.524   
## F-statistic: 57.7 on 2 and 101 DF,  p-value: <2e-16
```