1. The shares of the U.S. automobile market held in 1990 by General Motors, Japanese manufacturers, Ford, Chrysler, and other manufacturers were respectively 36%, 26%, 21%, 9%, and 8%. Suppose that a new survey of 1,000 new-car buyers shows the following purchase frequencies: GM(391), Japanese(202), Ford(275), Chrysler(53), and Other(79). Test at 10% significance level to determine whether the current market shares differ from those of 1990. What type of error you might have committed in your decision?

The hypotheses are: H_0: The current market shares is as 1990 H_A: The current market shares is different from those 1990.

① point

The assumption is: Each expected Frequency (e_i) is at least 5

$e_i \geq 5$ for all $i = 1, 2, \dots, k$. ① point

The test statistic:

Class(i)	o_i	p_i	$e_i = np_i$	$\frac{(o_i - e_i)^2}{e_i}$
G.M	391	0.36	360	2.669
Japanese	202	0.26	260	12.938
Ford	275	0.21	210	20.119
Chrysler	53	0.09	90	15.211
Other	79	0.08	80	0.0125
Total	1000	1.00	1000	50.950

② points

$$\chi^2_c = \sum_{i=1}^{5} \frac{(o_i - e_i)^2}{e_i} = 50.950.$$

② points

The critical value: $\chi^2_{\alpha, k-1} = \chi^2_{.10, 4} = 7.7794$ ① point

The decision rule: Reject H_0 if $\chi^2_c > \chi^2_{\alpha, k-1}$ ① point

$\Rightarrow$ $50.950 > 7.7794$

$\Rightarrow$ Reject H_0.

The conclusion:

The current market shares differ from those 1990.

① point

Type of error: H_0 was rejected $\Rightarrow$ Type I error. ① point

2. A book marketing research study about the relationship between delivery time and computer-assisted ordering was conducted. A sample of 40 firms shows that 16 use computer-assisted ordering, while 24 do not. Furthermore, past data are used to categorize each firm's delivery times as below the industry average, equal to the industry average, or above the industry average as given in the table below:

	Delivery time			
Computer Ordering	Below average	Equal to average	Above average	② point
No	4 (8.4)	12 (9.6)	8 (6)	24
Yes	10 (5.6)	4 (6.4)	2 (4)	16
	14	16	10	40

Using the above table what do you conclude about the relationship between delivery time and computer-assisted ordering? Use 5% significance level.

The hypotheses are: H_o: The delivery time and computer assisted ordering are indep.	H_A: Delivery time and computer assisted ordering are not indep. ① point
The assumption is: The expected frequency for each cell is at least 5 ($e_i = n P_i \geq 5$ for all $i = 1, \dots, k$. ① point.	

The test statistic value: $e_{11} = 8.4$, $e_{12} = 9.6$, $e_{13} = 6$, $e_{21} = 5.6$, $e_{22} = 6.4$, $e_{23} = 4 < 5$

Combine last Column with the previous one to get;

	Below average	Equal or above average
No	4 (8.4)	20 (15.6)
yes	10 (5.6)	6 (10.4)
Total	14	26

③ points for Combining and Calculation

$$\chi_c^2 = \sum_1^2 \sum_1^2 \frac{(O_{ij} - e_{ij})^2}{e_{ij}}$$

$$= \frac{(4-8.4)^2}{8.4} + \frac{(20-15.6)^2}{15.6} + \frac{(10-5.6)^2}{5.6} + \frac{(6-10.4)^2}{10.4} \Bigg\} \text{④ points}$$

$$= 2.3048 + 1.2410 + 3.471 + 1.8615$$

$$= 8.8645 \ \} \text{② point}$$

The critical value:

$$\chi^2_{\alpha,(r-1)(c-1)} = \chi^2_{.05,(2-1)(2-1)} = \chi^2_{.05,1} = 3.8415 \quad \text{① point}$$

The decision rule:

Reject Ho if $\chi_c^2 > \chi^2_{\alpha,(r-1)(c-1)}$

$\Rightarrow 8.8645 > 3.8415 \Rightarrow$ Reject Ho ① point

The conclusion:

The delivery time and Computer assisted ordering are not independent (Dependent). ① point

without Combining:

T.S $\chi_c^2 = \sum\sum \frac{(O_{ij} - e_{ij})^2}{e_{ij}} = \frac{(4-8.4)^2}{8.4} + \frac{(12-9.6)^2}{9.6} + \frac{(8-6)^2}{6} + \frac{(10-5.6)^2}{5.6} + \frac{(4-6.4)^2}{6.4} + \frac{(2-4)^2}{4}$

$= 2.3048 + 0.6000 + 0.6667 + 3.4571 + 0.9000 + 1.000$

$= 8.9286$ ② point.

C.V.: $\chi^2_{\alpha,(r-1)(c-1)} = \chi^2_{.05,(2-1)(3-1)} = \chi^2_{.05,2} = 5.9915$ ① point.

D.R: Reject Ho if $\chi_c^2 > \chi^2_{\alpha,(r-1)(c-1)} \Rightarrow 8.9286 > 5.9915$ ∴ Reject Ho ① point

3. Accu-Copiers, Inc., sells and services the Accu-500 copying machine. As part of its standard service contract, the company agrees to perform routine service on this copier. To obtain information about the time it takes to perform routine service, Accu-Copiers has collected data for 11 service calls. The data are as follows:

Copiers serviced (X)	4	2	5	7	1	3	4	5	2	4	6
Minutes required (Y)	140	68	103	145	60	51	103	134	110	90	112

Do the data provide sufficient evidence to conclude that there is a direct relationship between the number of copiers serviced and the time it takes to be serviced? Use a significance level of 0.025.

The correlation coefficient = $r = \dfrac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}} = \dfrac{4773 - \frac{(43)(1116)}{11}}{\sqrt{\left(201 - \frac{(43)^2}{11}\right)\left(123368 - \frac{(1116)^2}{11}\right)}}$ (2)

$= 0.7103$ (1) point.

The assumptions are: a. The data are interval or ratio leve (Quantitiv) b. The two variables are distributed as a bivariate normal distribution (2) points.

or $H_0: \rho \le 0$ vs $H_A: \rho > 0$

The hypotheses are: H_0: $\rho = 0$ H_A: $\rho \neq 0$ (1) point.

The test statistic value: $t_c = \dfrac{r}{\sqrt{\frac{(1-r^2)}{n-2}}} = \dfrac{0.7103}{\sqrt{\frac{(1-(.7103)^2}{11-2}}}$ (1) point

$= 3.027$ (1) point

The critical value: $t_{\alpha/2, n-2} = t_{.0125, 9} \approx t_{.01, 9} = 2.8214$ $(t_{.0125, 9} = 2.685011)$

or $t_{\alpha, n-2} = t_{.025, 9} = 2.2622$ (2) points

Decision Rule: Reject H_0 if $|t_c| > t_{\alpha/2, n-2}$ $\Rightarrow$ $3.027 > 2.8214$ Reject H_0. (1) point

or Reject H_0 if $t_c > t_{\alpha, n-1} \Rightarrow$ Reject H_0.

Conclusion: There is a significant linear (positive) relationship between the two variables. (1) point.

4. Enterprise Industries produces FRESH, a brand of liquid laundry detergent. In order to study the relationship between the price and demand for FRESH, the company has gathered data concerning demand for FRESH over the last 30 sales periods where,
X: The *price* (in dollars) per bottle of FRESH and **Y**: The *demand* for FRESH (in 100,000's of bottles)
The following sums were obtained,

$n = 30$, $\sum x = 112.05$, $\sum x^2 = 418.742$, $\sum y = 251.48$, $\sum y^2 = 2121.53$, $\sum xy = 938.442$, and $SSE = 10.495$

Assuming that X is the independent variable and Y is the dependent variable then

(2) points.

1. The assumptions are: a. Error values are indep. b. Error values are normally distributed
c. Errors have Constant Variance d. The relationship between X & Y is linear

2. The fitted regression equation is: $\hat{Y} = \underline{21.6524} + \underline{-3.5528}\, X$ (1) point

$$b_1 = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} = \frac{938.442 - \frac{(112.05)(251.48)}{30}}{418.742 - \frac{(112.05)^2}{30}} = \frac{-0.8358}{0.23525} = -3.5528$$

(1) point

$$b_0 = \bar{y} - b_1\bar{x} = \left(\frac{251.48}{30}\right) - (-3.5528)\left(\frac{112.05}{30}\right)$$

$$= 21.6524$$ (1) point

3. The standard error of the regression model is:

$$S_e = \sqrt{MSE} = \sqrt{\frac{SSE}{n-k-1}} = \sqrt{\frac{10.495}{30-1-1}} = 0.6122$$ } (1) point.

4. The predicted value of the *demand* if the *price* was \$4.00 is:

$$\hat{y}_{1\,|\,x=4.00} = 21.6524 - 3.5528(4) = 7.4412$$
$$= 744{,}120 \text{ bottels}$$ } (1) point

5. A 99% C.I. for the *demand* if the *price* of a bottle was \$4.00 is:

$x_p = 4.00$, $\bar{x} = \frac{112.05}{30} = 3.7350$, $\sum(x-\bar{x})^2 = \sum x^2 - \frac{(\sum x)^2}{n} = 418.742 - \frac{(112.05)^2}{30}$
(1) point
$= 0.2353$

$t_{\alpha/2, n-2} = t_{.01/2, 28} = t_{.005, 28} = 2.7633$

A 99% C.I. is: $\hat{y} \pm t_{\alpha/2, n-2} \cdot S_e \cdot \sqrt{1 + \frac{1}{n} + \frac{(x_p - \bar{x})^2}{\sum(x-\bar{x})^2}}$

$\Rightarrow 7.4412 \pm (2.7633)(.6122)\sqrt{1 + \frac{1}{30} + \frac{(4-3.735)^2}{0.2353}}$

$\Rightarrow 7.4412 \pm 1.9523 \Rightarrow [5.4889, 9.3935]$

(1) point (1) point

Do you think that the demand will increase by at most 300,000 bottles if the price was decreased by $1? Justify your answer using 10% significance level.

The hypotheses are: H_o: $\beta_1 \leq 3$ H_A: $\beta_1 > 3$	1 point
The test statistic: $t_c = \frac{b_1 - \beta_{1o}}{S_{b_1}} = \frac{-3.5528 - 3}{0.6122/\sqrt{0.2353}}$, 1 point $S_{b_1} = \frac{S_e}{\sqrt{\Sigma(x-\bar{x})^2}} = 1.2621$ $= -5.1921$ 1 point	
The critical value: $t_{\alpha, n-2} = t_{.10, 28} = 1.3125$	1 point
The decision rule: Reject H_o if $t_c > t_{\alpha, n-2}$ $\Rightarrow -5.1921 \not> 1.3125$ $\therefore$ Do not reject H_o	1 point
The conclusion: The demand will increase by at most 300,000 bottels	1 point

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