

# **Two-Group Hypothesis Tests: Excel 2003 T-TEST Command**

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by

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*Slides and audio at: [www.StatLit.org/](http://www.StatLit.org/)*

*[pdf/T-TEST-Command-Excel-2003-6up.pdf](http://www.StatLit.org/pdf/T-TEST-Command-Excel-2003-6up.pdf)*

# Excel 2003 T-TEST Command

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**Purpose:** Calculate likelihood (p-value) of getting the observed difference in two sample means (or more extreme) by chance in random samples – assuming there is no difference in the two population means (the Null Hypothesis).

## Four Inputs:

- 1) Array or range of two samples.
- 2) Alpha cutoff.
- 3) Tails: 1 (Excel matches Alternate with sample means) or 2.
- 4) Type of T-TEST. 1 dependent, matched subjects.  
2: population variances unknown but equal. [Often true]  
3: population variances unknown & unequal. [Conservative]

## Use this data: B1:I241

Data for Q1-Q4 (B-E) is Binary: 0=No, 1=Yes.

Data for Q5-Q6 (F-G) is Ordinal (discrete): 1-5.

Data for Q7-Q8 (H-I) is Quantitative (ratio).

|   | A  | B  | C  | D  | E  | F  | G  | H  | I  |
|---|----|----|----|----|----|----|----|----|----|
| 1 | ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |
| 2 | 1  | 0  | 1  | 0  | 0  | 3  | 5  | 67 | 5  |
| 3 | 2  | 0  | 1  | 0  | 1  | 4  | 1  | 62 | 4  |
| 4 | 3  | 0  | 1  | 0  | 1  | 3  | 4  | 60 | 5  |
| 5 | 4  | 0  | 1  | 1  | 0  | 4  | 5  | 60 | 4  |
| 6 | 5  | 0  | 0  | 1  | 0  | 3  | 1  | 71 | 3  |

Excel instructions and data at:

[www.StatLit.org/xls/2012Isaacson240Data.xls](http://www.StatLit.org/xls/2012Isaacson240Data.xls)

# Approach

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Excel's two-population T-Test command requires that the data be “stacked” (separated into two groups) by the value of the predictor. Predictor must be binary.

If the binary predictor is the answer to Q1, then *the entire data set* must be sorted by Q1.

The Excel “Sort” requires that the entire data set be selected **before** invoking the sort command. A common mistake is to sort just a single column rather than the entire dataset.

Unfortunately Excel does not have a “stacked” or conditional T-Test. The T-Test command will not automatically update p-values if data is changed.

# A: Select data.

## From Data tab, select Sort

|    | A  | B  | C  | D  | E  | F  | G  | H  | I  | J | K       | L       | M       | N       |
|----|----|----|----|----|----|----|----|----|----|---|---------|---------|---------|---------|
| 1  | ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |   | Q2 Q1=1 | Q2 Q1=0 | Q7 Q1=1 | Q7 Q1=C |
| 2  | 1  | 1  | 0  | 0  | 0  | 5  | 1  | 75 | 7  |   |         |         |         |         |
| 3  | 2  | 0  | 0  | 1  | 0  | 1  | 1  | 58 | 6  |   |         |         |         |         |
| 4  | 3  | 1  | 0  | 0  | 0  | 3  | 4  | 76 | 5  |   |         |         |         |         |
| 5  | 4  | 0  | 1  | 1  | 1  | 3  | 2  | 89 | 6  |   |         |         |         |         |
| 6  | 5  | 0  | 1  | 1  | 1  | 4  | 4  | 77 | 7  |   |         |         |         |         |
| 7  | 6  | 1  | 0  | 1  | 0  | 3  | 4  | 73 | 6  |   |         |         |         |         |
| 8  | 7  | 1  | 0  | 0  | 0  | 4  | 1  | 72 | 6  |   |         |         |         |         |
| 9  | 8  | 1  | 0  | 0  | 0  | 4  | 1  | 88 | 6  |   |         |         |         |         |
| 10 | 9  | 1  | 0  | 0  | 0  | 4  | 3  | 90 | 6  |   |         |         |         |         |
| 11 | 10 | 1  | 0  | 0  | 0  | 3  | 4  | 39 | 5  |   |         |         |         |         |
| 12 | 11 | 1  | 0  | 0  | 0  | 5  | 2  | 40 | 4  |   |         |         |         |         |
| 13 | 12 | 1  | 1  | 1  | 0  | 5  | 5  | 68 | 9  |   |         |         |         |         |
| 14 | 13 | 1  | 1  | 1  | 1  | 5  | 1  | 71 | 8  |   |         |         |         |         |
| 15 | 14 | 1  | 0  | 1  | 0  | 3  | 1  | 98 | 4  |   |         |         |         |         |
| 16 | 15 | 1  | 1  | 0  | 1  | 3  | 1  | 80 | 7  |   |         |         |         |         |
| 17 | 16 | 0  | 0  | 1  | 0  | 4  | 1  | 93 | 6  |   |         |         |         |         |
| 18 | 17 | 0  | 0  | 1  | 0  | 2  | 1  | 41 | 6  |   |         |         |         |         |

  

**Sort** [?] [X]

Sort by   Ascending  Descending

Then by   Ascending  Descending

Then by   Ascending  Descending

My data range has  Header row  No header row

## **B: Sort Data.**

### **Prepare column headings.**

|    | A  | B  | C  | D  | E  | F  | G  | H  | I  | J | K       | L       |
|----|----|----|----|----|----|----|----|----|----|---|---------|---------|
| 1  | ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |   | Q2 Q1=1 | Q2 Q1=0 |
| 2  | 1  | 1  | 0  | 0  | 0  | 5  | 1  | 75 | 7  |   |         |         |
| 3  | 3  | 1  | 0  | 0  | 0  | 3  | 4  | 76 | 5  |   |         |         |
| 4  | 6  | 1  | 0  | 1  | 0  | 3  | 4  | 73 | 6  |   |         |         |
| 5  | 7  | 1  | 0  | 0  | 0  | 4  | 1  | 72 | 6  |   |         |         |
| 6  | 8  | 1  | 0  | 0  | 0  | 4  | 1  | 88 | 6  |   |         |         |
| 7  | 9  | 1  | 0  | 0  | 0  | 4  | 3  | 90 | 6  |   |         |         |
| 8  | 10 | 1  | 0  | 0  | 0  | 3  | 4  | 39 | 5  |   |         |         |
| 9  | 11 | 1  | 0  | 0  | 0  | 5  | 2  | 40 | 4  |   |         |         |
| 10 | 12 | 1  | 1  | 1  | 0  | 5  | 5  | 68 | 9  |   |         |         |
| 11 | 13 | 1  | 1  | 1  | 1  | 5  | 1  | 71 | 8  |   |         |         |
| 12 | 14 | 1  | 0  | 1  | 0  | 3  | 1  | 98 | 4  |   |         |         |
| 13 | 15 | 1  | 1  | 0  | 1  | 3  | 1  | 80 | 7  |   |         |         |
| 14 | 18 | 1  | 0  | 1  | 1  | 4  | 2  | 42 | 8  |   |         |         |
| 15 | 19 | 1  | 0  | 0  | 0  | 3  | 3  | 39 | 6  |   |         |         |
| 16 | 22 | 1  | 0  | 1  | 0  | 5  | 4  | 55 | 6  |   |         |         |
| 17 | 23 | 1  | 1  | 0  | 0  | 4  | 2  | 74 | 6  |   |         |         |
| 18 | 24 | 1  | 0  | 1  | 0  | 5  | 2  | 36 | 4  |   |         |         |
| 19 | 26 | 1  | 1  | 1  | 1  | 5  | 2  | 49 | 7  |   |         |         |
| 20 | 31 | 1  | 1  | 0  | 0  | 5  | 1  | 76 | 6  |   |         |         |
| 21 | 32 | 1  | 0  | 0  | 0  | 3  | 1  | 92 | 4  |   |         |         |
| 22 | 34 | 1  | 0  | 0  | 0  | 5  | 5  | 62 | 4  |   |         |         |
| 23 | 35 | 1  | 0  | 0  | 0  | 5  | 4  | 54 | 7  |   |         |         |
| 24 | 36 | 1  | 0  | 0  | 0  | 5  | 5  | 68 | 5  |   |         |         |
| 25 | 38 | 1  | 1  | 0  | 1  | 5  | 5  | 60 | 6  |   |         |         |
| 26 | 40 | 1  | 1  | 0  | 0  | 4  | 2  | 61 | 8  |   |         |         |

Create headings that show what column or question is being tested and what column or question is used to split the data into two groups.

Q1 is used as the two-group splitter in this example. Any field with binary data can be used.

The vertical bar “|” means “given” so Q2|Q1=1 indicates the values of Q2 for which Q1 equals 1.

# C: Copy stacked data to separate columns

Q1=1

| Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |  | Q2 Q1=1 | Q2 Q1=0 | Q7 Q1=1 | Q7 Q1=0 | Q8 Q1=1 | Q8 Q1=0 |
|----|----|----|----|----|----|----|----|--|---------|---------|---------|---------|---------|---------|
| 1  | 0  | 0  | 0  | 5  | 1  | 75 | 7  |  | 0       | 0       | 75      | 58      | 7       | 6       |
| 1  | 0  | 0  | 0  | 3  | 4  | 76 | 5  |  | 0       | 1       | 76      | 89      | 5       | 6       |
| 1  | 0  | 1  | 0  | 3  | 4  | 73 | 6  |  | 0       | 1       | 73      | 77      | 6       | 7       |
| 1  | 0  | 0  | 0  | 4  | 1  | 72 | 6  |  | 0       | 0       | 72      | 93      | 6       | 6       |
| 1  | 0  | 0  | 0  | 4  | 1  | 88 | 6  |  | 0       | 0       | 88      | 41      | 6       | 6       |
| 1  | 0  | 0  | 0  | 4  | 3  | 90 | 6  |  | 0       | 1       | 90      | 65      | 6       | 7       |
| 1  | 0  | 0  | 0  | 3  | 4  | 39 | 5  |  | 0       | 0       | 39      | 70      | 5       | 6       |
| 1  | 0  | 0  | 0  | 5  | 2  | 40 | 4  |  | 0       | 0       | 40      | 65      | 4       | 5       |
| 1  | 1  | 1  | 0  | 5  | 5  | 68 | 9  |  | 1       | 1       | 68      | 89      | 9       | 7       |
| 1  | 1  | 1  | 1  | 5  | 1  | 71 | 8  |  | 1       | 1       | 71      | 64      | 8       | 4       |
| 1  | 0  | 1  | 0  | 3  | 1  | 98 | 4  |  | 0       | 0       | 98      | 82      | 4       | 5       |
| 1  | 1  | 0  | 1  | 3  | 1  | 80 | 7  |  | 1       | 1       | 80      | 82      | 7       | 4       |
| 1  | 0  | 1  | 1  | 4  | 2  | 42 | 8  |  | 0       | 1       | 42      | 75      | 8       | 7       |
| 1  | 0  | 0  | 0  | 3  | 3  | 39 | 6  |  | 0       | 1       | 39      | 80      | 6       | 5       |
| 1  | 0  | 1  | 0  | 5  | 4  | 55 | 6  |  | 0       | 0       | 55      | 83      | 6       | 6       |
| 1  | 1  | 0  | 0  | 4  | 2  | 74 | 6  |  | 1       |         | 74      |         | 6       |         |
| 1  | 0  | 1  | 0  | 5  | 2  | 36 | 4  |  | 0       |         | 36      |         | 4       |         |
| 1  | 1  | 1  | 1  | 5  | 2  | 49 | 7  |  | 1       |         | 49      |         | 7       |         |
| 1  | 1  | 0  | 0  | 5  | 1  | 76 | 6  |  | 1       |         | 76      |         | 6       |         |
| 1  | 0  | 0  | 0  | 3  | 1  | 92 | 4  |  | 0       |         | 92      |         | 4       |         |
| 1  | 0  | 0  | 0  | 5  | 5  | 62 | 4  |  | 0       |         | 62      |         | 4       |         |
| 1  | 0  | 0  | 0  | 5  | 4  | 54 | 7  |  | 0       |         | 54      |         | 7       |         |
| 1  | 0  | 0  | 0  | 5  | 5  | 68 | 5  |  | 0       |         | 68      |         | 5       |         |
| 1  | 1  | 0  | 1  | 5  | 5  | 60 | 6  |  | 1       |         | 60      |         | 6       |         |
| 1  | 1  | 0  | 0  | 4  | 2  | 61 | 8  |  | 1       |         | 61      |         | 8       |         |
| 0  | 0  | 1  | 0  | 1  | 1  | 58 | 6  |  |         |         |         |         |         |         |
| 0  | 1  | 1  | 1  | 3  | 2  | 89 | 6  |  |         |         |         |         |         |         |

Q1=0.

## **D: Enable Data Analysis Toolpak**

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If "Data Analysis" is not shown on Data tab, install it.

- Excel 2010: From File menu, select Options/Add-Ins.
- Excel 2008: From Microsoft button, select "Add Excel Options" in lower right corner.
- Excel 2003 If "Data Analysis Toolpak" is not shown under Tools menu, install it. From TOOLS menu, select ADD-INS.

Check the check box for "Data Analysis Toolpak". Press the OK command button. The Data Analysis command should be added to the appropriate menu. If not remove and reinstall.



# **T-TEST Command Procedure Given Separated Data**

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- 1: From Tool Menu, select “Data Analysis”.
- 2: From Data Analysis window, select “t-test: Two-sample with unequal variances”.
- 3: In T-Test window, enter input and output options.
4. Obtain results of t-test. Summarize the test results.

# 1) From the Data menu, select Data Analysis

The screenshot shows the Microsoft Excel 2003 interface. The 'Data' menu is open, and 'Data Analysis...' is highlighted. The spreadsheet contains data for two groups, Q1 and Q2, with columns for ID, Q1, Q2, Q3, Q4, Q5, Q6, Q7, and Q8. The formula bar shows 'R2' and the active cell contains '=1'.

|    | A  | B  | C  | D  | E  | F  | G  | H  |
|----|----|----|----|----|----|----|----|----|
| 1  | ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 |
| 2  | 1  | 1  | 0  | 0  | 0  | 5  | 1  | 75 |
| 3  | 3  | 1  | 0  | 0  | 0  | 3  | 4  | 76 |
| 4  | 6  | 1  | 0  | 1  | 0  | 3  | 4  | 73 |
| 5  | 7  | 1  | 0  | 0  | 0  | 4  | 1  | 72 |
| 6  | 8  | 1  | 0  | 0  | 0  | 4  | 1  | 88 |
| 7  | 9  | 1  | 0  | 0  | 0  | 4  | 3  | 90 |
| 8  | 10 | 1  | 0  | 0  | 0  | 3  | 4  | 39 |
| 9  | 11 | 1  | 0  | 0  | 0  | 5  | 2  | 40 |
| 10 | 12 | 1  | 1  | 1  | 0  | 5  | 5  | 68 |
| 11 | 13 | 1  | 1  | 1  | 1  | 5  | 1  | 71 |
| 12 | 14 | 1  | 0  | 1  | 0  | 3  | 1  | 98 |
| 13 | 15 | 1  | 1  | 0  | 1  | 3  | 1  | 80 |
| 14 | 18 | 1  | 0  | 1  | 1  | 4  | 2  | 42 |
| 15 | 19 | 1  | 0  | 0  | 0  | 3  | 3  | 39 |
| 16 | 22 | 1  | 0  | 1  | 0  | 5  | 4  | 55 |
| 17 | 23 | 1  | 1  | 0  | 0  | 4  | 2  | 74 |
| 18 | 24 | 1  | 0  | 1  | 0  | 5  | 2  | 36 |
| 19 | 26 | 1  | 1  | 1  | 1  | 5  | 2  | 49 |
| 20 | 31 | 1  | 1  | 0  | 0  | 5  | 1  | 76 |
| 21 | 32 | 1  | 0  | 0  | 0  | 3  | 1  | 92 |
| 22 | 34 | 1  | 0  | 0  | 0  | 5  | 5  | 62 |
| 23 | 35 | 1  | 0  | 0  | 0  | 5  | 4  | 54 |
| 24 | 36 | 1  | 0  | 0  | 0  | 5  | 5  | 68 |
| 25 | 38 | 1  | 1  | 0  | 1  | 5  | 5  | 60 |
| 26 | 40 | 1  | 1  | 0  | 0  | 4  | 2  | 61 |

## 2) Select T-Test Command: Two-Sample; Unequal Variances

| R2 | A  | B  | C  | D  | E  | F  | G  | H  | I  | J | K       | L       | M       | N       | O       | P       | Q        | R |
|----|----|----|----|----|----|----|----|----|----|---|---------|---------|---------|---------|---------|---------|----------|---|
| 1  | ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |   | Q2 Q1=1 | Q2 Q1=0 | Q7 Q1=1 | Q7 Q1=0 | Q8 Q1=1 | Q8 Q1=0 | Q2 by Q1 |   |
| 2  | 1  | 1  | 0  | 0  | 0  | 5  | 1  | 75 | 7  |   | 0       | 0       |         |         |         |         |          |   |
| 3  | 3  | 1  | 0  | 0  | 0  | 3  | 4  | 76 | 5  |   | 0       | 1       |         |         |         |         |          |   |
| 4  | 6  | 1  | 0  | 1  | 0  | 3  | 4  | 73 | 6  |   |         |         |         |         |         |         |          |   |
| 5  | 7  | 1  | 0  | 0  | 0  | 4  | 1  | 72 | 6  |   |         |         |         |         |         |         |          |   |
| 6  | 8  | 1  | 0  | 0  | 0  | 4  | 1  | 88 | 6  |   |         |         |         |         |         |         |          |   |
| 7  | 9  | 1  | 0  | 0  | 0  | 4  | 3  | 90 | 6  |   |         |         |         |         |         |         |          |   |
| 8  | 10 | 1  | 0  | 0  | 0  | 3  | 4  | 39 | 5  |   |         |         |         |         |         |         |          |   |
| 9  | 11 | 1  | 0  | 0  | 0  | 5  | 2  | 40 | 4  |   |         |         |         |         |         |         |          |   |
| 10 | 12 | 1  | 1  | 1  | 0  | 5  | 5  | 68 | 9  |   |         |         |         |         |         |         |          |   |
| 11 | 13 | 1  | 1  | 1  | 1  | 5  | 1  | 71 | 8  |   |         |         |         |         |         |         |          |   |
| 12 | 14 | 1  | 0  | 1  | 0  | 3  | 1  | 98 | 4  |   |         |         |         |         |         |         |          |   |
| 13 | 15 | 1  | 1  | 0  | 1  | 3  | 1  | 80 | 7  |   |         |         |         |         |         |         |          |   |
| 14 | 18 | 1  | 0  | 1  | 1  | 4  | 2  | 42 | 8  |   |         |         |         |         |         |         |          |   |
| 15 | 19 | 1  | 0  | 0  | 0  | 3  | 3  | 39 | 6  |   | 0       | 1       |         |         |         |         |          |   |
| 16 | 22 | 1  | 0  | 1  | 0  | 5  | 4  | 55 | 6  |   | 0       | 0       |         |         |         |         |          |   |
| 17 | 23 | 1  | 1  | 0  | 0  | 4  | 2  | 74 | 6  |   | 1       |         |         |         |         |         |          |   |
| 18 | 24 | 1  | 0  | 1  | 0  | 5  | 2  | 36 | 4  |   | 0       |         |         |         |         |         |          |   |
| 19 | 26 | 1  | 1  | 1  | 1  | 5  | 2  | 49 | 7  |   | 1       |         |         |         |         |         |          |   |
| 20 | 31 | 1  | 1  | 0  | 0  | 5  | 1  | 76 | 6  |   | 1       |         |         |         |         |         |          |   |
| 21 | 32 | 1  | 0  | 0  | 0  | 3  | 1  | 92 | 4  |   | 0       |         |         |         |         |         |          |   |
| 22 | 34 | 1  | 0  | 0  | 0  | 5  | 5  | 62 | 4  |   | 0       |         |         |         |         |         |          |   |
| 23 | 35 | 1  | 0  | 0  | 0  | 5  | 4  | 54 | 7  |   | 0       |         |         |         |         |         |          |   |
| 24 | 36 | 1  | 0  | 0  | 0  | 5  | 5  | 68 | 5  |   | 0       |         |         |         |         |         |          |   |
| 25 | 38 | 1  | 1  | 0  | 1  | 5  | 5  | 60 | 6  |   | 1       |         |         |         |         |         |          |   |
| 26 | 40 | 1  | 1  | 0  | 0  | 4  | 2  | 61 | 8  |   | 1       |         |         |         |         |         |          |   |

  

| Data Analysis  |  |
|--|--|
| Analysis Tools                                       |  |
| Histogram  |  |
| Moving Average                                       |  |
| Random Number Generation                             |  |
| Rank and Percentile                                  |  |
| Regression   |  |
| Sampling   |  |
| t-Test: Paired Two Sample for Means                  |  |
| t-Test: Two-Sample Assuming Equal Variances          |  |
| <b>t-Test: Two-Sample Assuming Unequal Variances</b> |  |
| z-Test: Two Sample for Means                         |  |
| OK   |  |
| Cancel   |  |
| Help   |  |

  

| Q7 by Q1 | R |
|----------|---|
|          |   |

## 3) Enter Input & Output: Q2 by Q1

| K       | L       | M       | N       | O       | P       | Q        | R | S |
|---------|---------|---------|---------|---------|---------|----------|---|---|
| Q2 Q1=1 | Q2 Q1=0 | Q7 Q1=1 | Q7 Q1=0 | Q8 Q1=1 | Q8 Q1=0 | Q2 by Q1 |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 0       | 1       |         |         |         |         |          |   |   |
| 0       | 1       |         |         |         |         |          |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 0       | 1       |         |         |         |         |          |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 1       | 1       |         |         |         |         |          |   |   |
| 1       | 1       |         |         |         |         |          |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 1       | 1       |         |         |         |         |          |   |   |
| 0       | 1       |         |         |         |         |          |   |   |
| 0       | 1       |         |         |         |         |          |   |   |
| 0       | 0       |         |         |         |         |          |   |   |
| 1       |         |         |         |         |         |          |   |   |
| 0       |         |         |         |         |         |          |   |   |
| 1       |         |         |         |         |         |          |   |   |
| 1       |         |         |         |         |         |          |   |   |
| 0       |         |         |         |         |         |          |   |   |
| 0       |         |         |         |         |         |          |   |   |
| 0       |         |         |         |         |         |          |   |   |
| 0       |         |         |         |         |         |          |   |   |
| 1       |         |         |         |         |         |          |   |   |
| 1       |         |         |         |         |         |          |   |   |

  

**t-Test: Two-Sample Assuming Unequal Variances**

Input

Variable 1 Range: \$K\$1:\$K\$26

Variable 2 Range: \$L\$1:\$L\$16

Hypothesized Mean Difference: 0

Labels

Alpha: 0.05

Output options

Output Range: \$R\$2

New Worksheet Ply:

New Workbook

OK Cancel Help

## 4) Excel-Generated Results: Q2 by Q1

| t-Test: Two-Sample Assuming Unequal Variances |         |         |
|---|---------|---------|
|   | Q2 Q1=1 | Q2 Q1=0 |
| Mean  | 0.32    | 0.53    |
| Variance                                      | 0.23    | 0.27    |
| Observations                                  | 25      | 15      |
| Hypothesized Mean Difference                  | 0       |         |
| df  | 28      |         |
| t Stat  | -1.30   |         |
| P(T<=t) one-tail                              | 0.10    |         |
| t Critical one-tail                           | 1.70    |         |
| P(T<=t) two-tail                              | 0.20    |         |
| t Critical two-tail                           | 2.05    |         |

Difference in Q2 proportions by Q1 is not statistically significant  
 Technical: Fail to reject the null hypothesis for Q2 by Q1.

## 3) Enter Input and Output: Q7 by Q1

| M       | N       | O       | P       | Q        | R | S | T |
|---------|---------|---------|---------|----------|---|---|---|
| Q7 Q1=1 | Q7 Q1=0 | Q8 Q1=1 | Q8 Q1=0 | Q2 by Q1 |   |   |   |
| 75      | 58      | 7       | 6       |          |   |   |   |
| 76      | 89      | 5       | 6       |          |   |   |   |
| 73      | 77      | 6       | 7       |          |   |   |   |
| 72      | 93      | 6       | 6       |          |   |   |   |
| 88      | 41      | 6       | 6       |          |   |   |   |
| 90      | 65      | 6       | 7       |          |   |   |   |
| 39      | 70      | 5       | 6       |          |   |   |   |
| 40      | 65      | 4       | 5       |          |   |   |   |
| 68      | 89      | 9       | 7       |          |   |   |   |
| 71      | 64      | 8       | 4       |          |   |   |   |
| 98      | 82      | 4       | 5       |          |   |   |   |
| 80      | 82      | 7       | 4       |          |   |   |   |
| 42      | 75      | 8       | 7       |          |   |   |   |
| 39      | 80      | 6       | 5       |          |   |   |   |
| 55      | 83      | 6       | 6       |          |   |   |   |
| 74      |         | 6       |         |          |   |   |   |
| 36      |         | 4       |         | Q7 by Q1 |   |   |   |
| 49      |         | 7       |         |          |   |   |   |
| 76      |         | 6       |         |          |   |   |   |
| 92      |         | 4       |         |          |   |   |   |
| 62      |         | 4       |         |          |   |   |   |
| 54      |         | 7       |         |          |   |   |   |
| 68      |         | 5       |         |          |   |   |   |
| 60      |         | 6       |         |          |   |   |   |
| 61      |         | 8       |         |          |   |   |   |

**t-Test: Two-Sample Assuming Unequal Variances**

Input

Variable 1 Range:

Variable 2 Range:

Hypothesized Mean Difference:

Labels

Alpha:

Output options

Output Range:

New Worksheet Ply:

New Workbook

OK Cancel Help

## 4) Excel-Generated Results: Q7 by Q1

| Q7 by Q1                                      |  |         |         |
|---|--|---------|---------|
| t-Test: Two-Sample Assuming Unequal Variances |  |         |         |
|   |  | Q7 Q1=1 | Q7 Q1=0 |
| Mean  |  | 65.52   | 74.2    |
| Variance                                      |  | 318.93  | 192.03  |
| Observations                                  |  | 25      | 15      |
| Hypothesized Mean Difference                  |  | 0       |         |
| df  |  | 35      |         |
| t Stat  |  | -1.72   |         |
| P(T<=t) one-tail                              |  | 0.05    |         |
| t Critical one-tail                           |  | 1.69    |         |
| P(T<=t) two-tail                              |  | 0.09    |         |
| t Critical two-tail                           |  | 2.03    |         |

Difference in Q7 means by Q1 IS statistically significant (1 tail)

Technical: Reject the null hypothesis for Q7 by Q1 (1 tail)

## 3) Enter Input and Output: Q8 by Q1

| O       | P       | Q   | R | S | T |
|---------|---------|---|---|---|---|
| Q8 Q1=1 | Q8 Q1=0 | t-Test: Two-Sample Assuming Unequal Variances   |   |   |   |
| 7       | 6       | Input<br>Variable 1 Range: \$O\$1:\$O\$26<br>Variable 2 Range: \$P\$1:\$P\$16<br>Hypothesized Mean Difference: 0<br><input checked="" type="checkbox"/> Labels<br>Alpha: 0.05 |   |   |   |
| 5       | 6       | Output options<br><input checked="" type="radio"/> Output Range: \$R\$18<br><input type="radio"/> New Worksheet Ply:<br><input type="radio"/> New Workbook                    |   |   |   |
| 6       | 7       | OK  |   |   |   |
| 6       | 6       | Cancel  |   |   |   |
| 6       | 6       | Help  |   |   |   |
| 6       | 7       |   |   |   |   |
| 5       | 6       |   |   |   |   |
| 4       | 5       |   |   |   |   |
| 9       | 7       |   |   |   |   |
| 8       | 4       |   |   |   |   |
| 4       | 5       |   |   |   |   |
| 7       | 4       |   |   |   |   |
| 8       | 7       |   |   |   |   |
| 6       | 5       |   |   |   |   |
| 6       | 6       |   |   |   |   |
| 6       |         |   |   |   |   |
| 4       |         | Q8 by Q1  |   |   |   |
| 7       |         |   |   |   |   |
| 6       |         |   |   |   |   |
| 4       |         |   |   |   |   |
| 4       |         |   |   |   |   |
| 7       |         |   |   |   |   |
| 5       |         |   |   |   |   |
| 6       |         |   |   |   |   |
| 8       |         |   |   |   |   |



## 4) Excel-Generated Results: Q8 by Q1

| Q8 by Q1 t-Test: Two-Sample Assuming Unequal Variances |  |         |         |
|--|--|---------|---------|
|  |  | Q8 Q1=1 | Q8 Q1=0 |
| Mean   |  | 6.00    | 5.80    |
| Variance   |  | 2.00    | 1.03    |
| Observations   |  | 25      | 15      |
| Hypothesized Mean Difference                           |  | 0       |         |
| df   |  | 37      |         |
| t Stat   |  | 0.52    |         |
| P(T<=t) one-tail                                       |  | 0.30    |         |
| t Critical one-tail                                    |  | 1.69    |         |
| P(T<=t) two-tail                                       |  | 0.61    |         |
| t Critical two-tail                                    |  | 2.03    |         |

Difference in Q8 means by Q1 is NOT statistically significant.

Technical: Fail to reject the null hypothesis for Q8 by Q1

## Summary

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In a one-tailed test, T-TEST always tests whether the positive difference between the larger sample statistic and the smaller is statistically-significant.

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“Reject the null hypothesis” and “Failure to reject the null hypothesis” are technical conclusions.

“A difference IS [or IS NOT] statistically significant” is a less-technical conclusion.

Use the less-technical expressions for everyday communication.