Note: In this problem set, expressions in green cells match corresponding expressions in the text answers.

```
Clear["Global`*"]
```

1 - 10 Sample Regression Line

Find and graph the sample regression line of y on x and the given data as points on the same axes.

1. (0, 1.0), (2, 2.1), (4, 2.9), (6, 3.6), (8, 5.2)

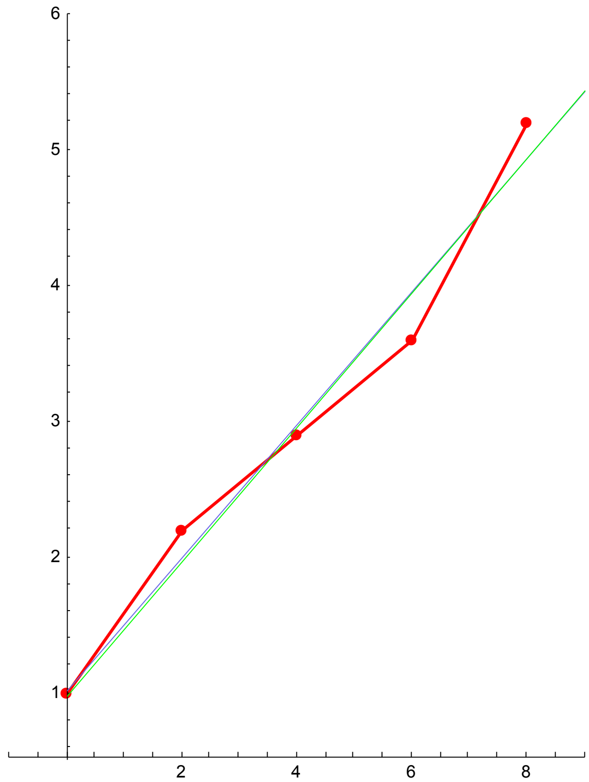
```
dat = {{0, 1.0}, {2, 2.2}, {4, 2.9}, {6, 3.6}, {8, 5.2}}
{{0, 1.}, {2, 2.2}, {4, 2.9}, {6, 3.6}, {8, 5.2}}
```

```
Fit[dat, {1, x}, x]
```

```
1.02 + 0.49 x
```

The fitting line found by the text answer is 0.98+0.495 x. As shown in the plot below, there is not a great difference between Mathematica's (blue) line and the text’s (green).

```
pch = ListLinePlot[dat, AspectRatio → 1.3,
  ImageSize → 300, PlotMarkers → Automatic,
  PlotStyle → Red, PlotRange → {{-1, 9}, {0.5, 6}}, Epilog →
   {{RGBColor[0.4, 0.4, 0.9], Line[{{0, 1.02}, {9, 1.02 + 0.49 * 9}}]},
    {{Green, Line[{{0, 0.98}, {9, 0.98 + 0.495 * 9}}]}}}]
```




3. x = Revolutions per minute, y = Power of a diesel engine (hp)

| | | | | | |
|---|---|---|---|---|---|
| **x** | **400** | **500** | **600** | **700** | **750** |
| **y** | **5800** | **10 300** | **14 200** | **18 800** | **21 000** |

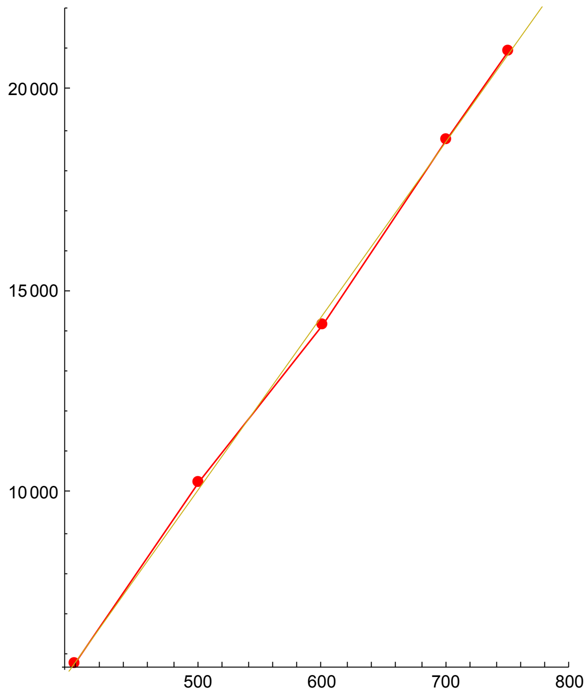
```
rdat = {{400, 5800}, {500, 10 300},
  {600, 14 200}, {700, 18 800}, {750, 21 000}}
{{400, 5800}, {500, 10 300}, {600, 14 200}, {700, 18 800}, {750, 21 000}}
```

```
Fit[rdat, {1, x}, x]
```

```
-11 457.9 + 43.1829 x
```

The above equation in green matches the answer in the text.

```
rch = ListLinePlot[rdat, AspectRatio → 1.3, ImageSize → 300,
  PlotMarkers → Automatic, PlotStyle → {Red, Thickness[0.003]},
  PlotRange → {{390, 800}, {5600, 22 000}},
  Epilog → {{RGBColor[0.8, 0.7, 0.1], Line[
      {{390, -11 457.9 + 43.182 * 390}, {800, -11 457.9 + 43.182 * 800}}]}}]
```




5. x = Brinell hardness, y = Tensile strength (in 1000 psi) of steel with 0.45% C tempered for 1 hour.

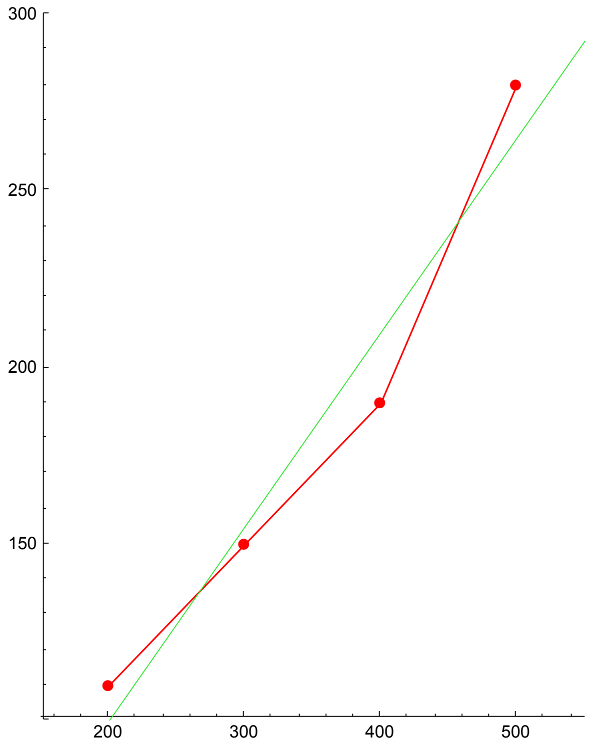
| | | | | |
|---|---|---|---|---|
| **x** | **200** | **300** | **400** | **500** |
| **y** | **110** | **150** | **190** | **280** |

```
brin = {{200, 110}, {300, 150}, {400, 190}, {500, 280}}
{{200, 110}, {300, 150}, {400, 190}, {500, 280}}

Fit[brin, {1, x}, x]

-10. + 0.55 x
```

```
bch = ListLinePlot[brin, AspectRatio → 1.3, ImageSize → 300,
  PlotMarkers → Automatic, PlotStyle → {Red, Thickness[0.003]},
  PlotRange → {{150, 550}, {100, 300}}, Epilog → {{RGBColor[0.2, 0.9, 0.2],
     Line[{{150, -10.0 + 0.55 * 150}, {550, -10.0 + 0.55 * 550}}]}}]
```




7. Ohm's law (section 2.9). x = Voltage (V), y = current (A). Also find the resistance R (Ω).

| | | | | | | |
|---|---|---|---|---|---|---|
| **x** | **40** | **40** | **80** | **80** | **110** | **110** |
| **y** | **5.1** | **4.8** | **0.0** | **10.3** | **13.0** | **12.7** |

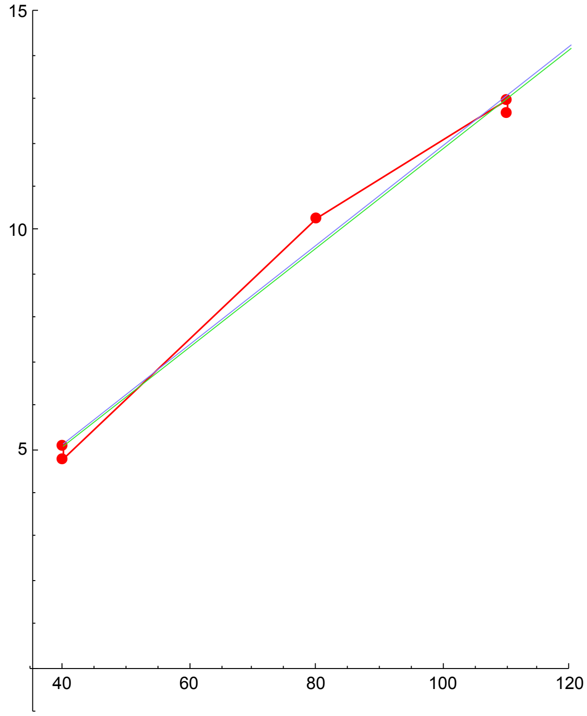
```
volt = {{40, 5.1}, {40, 4.8}, {80, 10.3}, {110, 13.0}, {110, 12.7}}
{{40, 5.1}, {40, 4.8}, {80, 10.3}, {110, 13.}, {110, 12.7}}
```

First I drop the point that represents zero current. Afterwards the fitting line of Mathematica (green) is almost the same as that of the text answer (blue).

```
Fit[volt, {1, x}, x]
0.55122 + 0.113537 x

model = LinearModelFit[volt, x, x]
FittedModel[ -0.555405+0.107027x ]
```

```
vch = ListLinePlot[volt, AspectRatio → 1.3,
  ImageSize → 300, PlotMarkers → Automatic,
  PlotStyle → {Red, Thickness[0.003]}, PlotRange → {{35, 120}, {-1, 15}},
  Epilog → {{RGBColor[0.2, 0.9, 0.2], Line[{{40, 0.5512 + 0.1135 * 40},
       {120, 0.5512 + 0.1135 * 120}}]}, {RGBColor[0.5, 0.5, 1],
     Line[{{40, 0.5932 + 0.1138 * 40}, {120, 0.5932 + 0.1138 * 120}}]}}]
```




The resistance is mysterious. Sum of volts divided by sum of amps does not do it, not quite. Instead, the resistance is equal to the reciprocal of the line slope.

```
vt = 160 + 220
```

380

```
at = 9.9 + 23.3 + 12.7
```

45.9

```
380 / 45.9
```

8.27887

```
1 / 0.1137
```

8.79507

9. Thermal conductivity of water. x = temperature (deg-F), y = conductivity (Btu/(hr × ft × deg-F). Also find y at room temperature 66 deg-F.

```
x    32     50     100    150    212
y  0.337  0.345  0.365  0.380  0.395
```

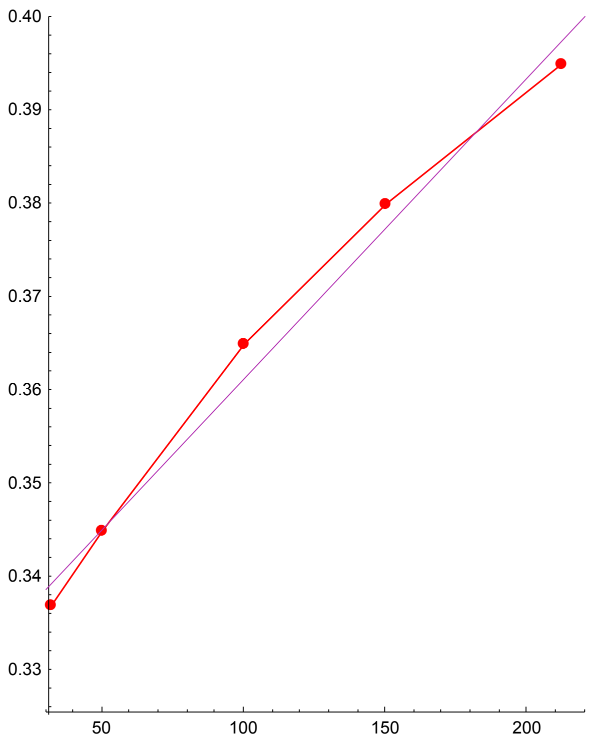
```
wat = {{32, 0.337}, {50, 0.345}, {100, 0.365}, {150, 0.380}, {212, 0.395}}
```

```
{{32, 0.337}, {50, 0.345}, {100, 0.365}, {150, 0.38}, {212, 0.395}}
```

```
Fit[wat, {1, x}, x]
```

```
0.329232 + 0.000323239 x
```

```
wch = ListLinePlot[wat, AspectRatio → 1.3, ImageSize → 300,
  PlotMarkers → Automatic, PlotStyle → {Red, Thickness[0.003]},
  PlotRange → {{30, 220}, {0.325, 0.4}},
  Epilog → {{RGBColor[0.7, 0.2, 0.7],
     Line[{{30, 0.329 + 0.000323 * 30}, {220, 0.329 + 0.000323 * 220}}]}}]
```




```
0.3292 + 0.000323 × 66
```

```
0.350518
```

I cannot find the right chop for the above expression to get the exact text answer decimals, which show as 0.35035.

12 - 15 Confidence intervals
Find a 95% confidence interval for the regression coefficient $\kappa_1$ , assuming (A2) and (A3) hold and using the sample.

13. In problem 3.

I gained some info on regression coefficients from *https : // mathematica.stackexchange.com/questions/19608/obtaining - standardised - regression - coefficients.* The keyword is ‘standardised’. The text answer does not care about standardized regression coefficients, which it seems are based on units of standard deviation. Regular non-standardized ones seem to simply be based on x length, and it is those I am after.

```
rdat = {{400, 5800}, {500, 10 300},
  {600, 14 200}, {700, 18 800}, {750, 21 000}}
{{400, 5800}, {500, 10 300}, {600, 14 200}, {700, 18 800}, {750, 21 000}}
```

Getting the model seems to go okay.

```
model = LinearModelFit[rdat, x, x]
FittedModel[ -11457.9+43.1829x ]
```

I try to use the method which the o.p. said he was using at the time of his post, which he considered to be only an estimate. I should say that in the docs for **LinearModelFit** it says that the default confidence level is .95, the same as requested in the problem description. (Raising the confidence level to .99 in the command does not change the output table values.) The text answer for the regression coefficient is $41.7 \leq \kappa_1 \leq 44.7$. The estimate for x in the below table is right in the middle of that interval. Adding and subtracting the **Standard Error** still results in an interval enclosed within the text answer. This seems to satisfy the current requirement.

```
model["ParameterTable", ConfidenceLevel → .95]
```

| | Estimate | Standard Error | t-Statistic | P-Value |
|---|---|---|---|---|
| 1 | −11457.9 | 379.612 | −30.1833 | 0.0000798837 |
| x | 43.1829 | 0.628769 | 68.6786 | $6.80261 \times 10^{-6}$ |

```
43.1829 + 0.628769
43.8117

43.1829 - 0.628769
42.5541
```

15. x = Humidity of air (%), y = Expansion of gelatin (%),

| x | 10 | 20 | 30 | 40 |
|---|---|---|---|---|
| y | 0.8 | 1.6 | 2.3 | 2.8 |

```
Clear[model]

air = {{10, 0.8}, {20, 1.6}, {30, 2.3}, {40, 2.8}}
{{10, 0.8}, {20, 1.6}, {30, 2.3}, {40, 2.8}}
```

```
model = LinearModelFit[air, x, x]
```

```
FittedModel[ 0.2+0.067x ]
```

Again the displayed regression coefficient is in the center of the text answer, which is 0.046 $\leq \kappa_1 \leq$ 0.088. Again adding and subtracting the Standard Error results in a completely double-bounded interval compared to the text answer.

```
model["ParameterTable", ConfidenceLevel → .95]
```

| | Estimate | Standard Error | t-Statistic | P-Value |
|---|---|---|---|---|
| 1 | 0.2 | 0.131339 | 1.52277 | 0.267257 |
| x | 0.067 | 0.00479583 | 13.9705 | 0.00508459 |

```
0.067 + 0.00479583
```

```
0.0717958
```

```
0.067 - 0.00479583
```

```
0.0622042
```

Again I will assume I found what I was looking for.