

**This take-home least-squares problem will account for 15 possible points on this exam.**

You must complete the following individually. You may use your textbook and notes, but may not receive assistance from your classmates or anyone other than Dr. Lamp. *This signed sheet must accompany the completed problem.* Attach any computer output to this sheet and show other work in the space below. By signing below, you certify that you completed the problems in accordance with these rules. No credit will be given to unsigned papers.

Signature(s) \_\_\_\_\_ Date \_\_\_\_\_

Below are data for the determination of arsenic in drinking water. In this experiment, six arsenic standards were prepared and measured. The results of the measurements are in the table below. A solution of unknown arsenic concentration were also analyzed, producing a signal of 0.334  $\mu\text{A}$ .

Arsenic Concentration (ppb)	Signal ( $\mu\text{A}$ )
12.4	0.266
14.3	0.305
16.7	0.355
18.2	0.382
20.7	0.433
22.4	0.468

- a. Perform a linear least-squares analysis on the data and determine the slope and intercept as well as the 95% confidence interval for both. Attach a printout of your plot and any other computer output you may have used (spreadsheet, Minitab, etc.).

Slope:  $0.0201 \pm 0.0004 \mu\text{A/ppb}$   
Intercept:  $0.017 \pm 0.007 \mu\text{A}$   
See next page for spreadsheet and plot.

- b. Determine the arsenic concentration in the unknown, with its 95% confidence interval.

$15.8 \pm 0.2 \text{ ppb}$

	x	y	xy	x <sup>2</sup>	n	y <sub>calc</sub>	d	d <sup>2</sup>	(y-y <sub>bar</sub> ) <sup>2</sup>	y <sub>Unknown</sub>
	12.4	0.266	3.2984	153.76	6	0.2666	-0.00062	4E-07	0.0104	0.334
	14.3	0.305	4.3615	204.49		0.3048	0.0001742	3E-08	0.004	
	16.7	0.355	5.9285	278.89		0.3531	0.0019145	4E-06	0.0002	
	18.2	0.382	6.9524	331.24		0.3832	-0.001248	2E-06	0.0002	
	20.7	0.433	8.9631	428.49		0.4335	-0.000518	3E-07	0.0042	
	22.4	0.468	10.483	501.76		0.4677	0.0002977	9E-08	0.01	
			0	0		0	0	0		
			0	0		0	0	0		
			0	0		0	0	0		
			0	0		0	0	0		
			0	0		0	0	0		
<b>Sums</b>	<b>104.7</b>	<b>2.209</b>	<b>39.987</b>	<b>1898.6</b>		<b>2.209</b>	<b>-6.38E-15</b>	<b>6E-06</b>	<b>0.029</b>	
	<b>D = 429.69</b>									
	<b>m = 0.02011</b>									
	<b>b = 0.01728</b>									
	<b>S<sub>y</sub> = 0.00122</b>									
	<b>S<sub>m</sub> = 0.00014</b>	<b>% S<sub>m</sub> = 0.7194</b>								
	<b>S<sub>b</sub> = 0.00257</b>	<b>% S<sub>b</sub> = 14.893</b>								
	<b>S<sub>x</sub> = 0.06688</b>	<b>% S<sub>x</sub> = 0.4246</b>								
	<b>x<sub>unk</sub> = 15.7509</b>									
	<b>x-int. = -0.8593</b>									
	<b>S<sub>x-int.</sub> = 0.13404</b>	<b>% S<sub>x-int.</sub> = -15.6</b>								
	<b>R<sup>2</sup> = 0.99979</b>									

  

	<b>D = (E12*F2)-(B12*B12)</b>			
	<b>m = ((D12*F2)-(C12*B12))/C14</b>			
	<b>b = ((E12*C12)-(D12*B12))/C14</b>			
	<b>S<sub>y</sub> = SQRT((I12/(F2-2)))</b>			
	<b>S<sub>m</sub> = SQRT(((C17^2*F2)/C14))</b>			
	<b>S<sub>b</sub> = SQRT(((C17^2*E12)/C14))</b>			
	<b>S<sub>x</sub> = (C17/ABS(C15))*SQRT(((1/1)+(C21^2*F2/C14)+(E12/C14)-((2*C21*B12)/C14)))</b>			
	<b>x<sub>unk</sub> = (J2-C16)/C15</b>			
	<b>x-int. = -C16/C15</b>			
	<b>S<sub>x-int.</sub> = (C17/C15)*SQRT(((1/F2)+AVERAGE(C2:C11))^2/(C15^2*DEVSQ(B2:B11)))</b>			
	<b>R<sup>2</sup> = 1-(I12/J12)</b>			
	<b>t = TINV(0.05,F2-2)</b>			

  

	value	unc. (s)	% rel unc.
<b>m</b>	0.0201	0.000	0.7194
<b>b</b>	0.0173	0.003	14.893
<b>x</b>	15.7509	0.06688	0.4246

  

<b>95% Confidence Intervals</b>				t= 2.7764
<b>m</b>	0.0201	+/-	0.0004	
<b>b</b>	0.0173	+/-	0.0071	
<b>x<sub>unk</sub></b>	15.751	+/-	0.1857	
<b>x-int.</b>	-0.859	+/-	0.3722	

