



**AP<sup>®</sup> Statistics**  
**2004 Sample Student Responses**  
**Form B**

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STATISTICS

SECTION II

Part A

Questions 1-5

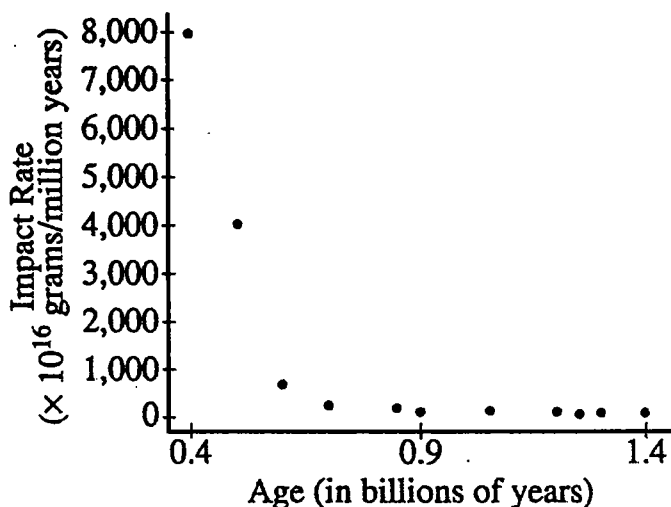
Spend about 65 minutes on this part of the exam.

Percent of Section II grade—75

A<sub>1</sub>

**Directions:** Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. The Earth's Moon has many impact craters that were created when the inner solar system was subjected to heavy bombardment of small celestial bodies. Scientists studied 11 impact craters on the Moon to determine whether there was any relationship between the age of the craters (based on radioactive dating of lunar rocks) and the impact rate (as deduced from the density of the craters). The data are displayed in the scatterplot below.



- (a) Describe the nature of the relationship between impact rate and age.

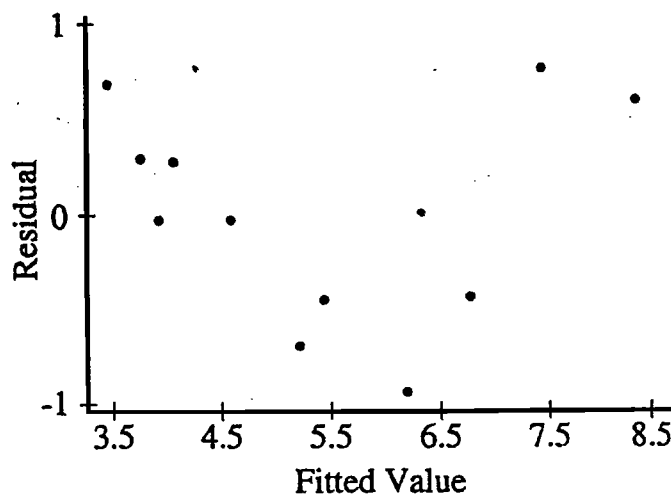
This data predicts that as the age of craters in billions of years increases the impact rate decreases. There appears to be a negative exponential relationship (of the form  $a^{-x}$ ) with asymptotes on the  $x$  and  $y$  axis.

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A<sub>2</sub>

Prior to fitting a linear regression model, the researchers transformed both impact rate and age by using logarithms. The following computer output and residual plot were produced.

Regression Equation: $\ln(\text{rate}) = 4.82 - 3.92 \ln(\text{age})$				
Predictor	Coef	SE Coef	T	P
Constant	4.8247	0.1931	24.98	0.000
$\ln(\text{age})$	-3.9232	0.4514	-8.69	0.000
S = 0.5977		R-Sq = 89.4%		R-Sq (adj) = 88.2%



(b) Interpret the value of  $r^2$ .

89.4% of variability in impact rate is accounted for by variation in age, under this logarithmic transformation.

(c) Comment on the appropriateness of this linear regression for modeling the relationship between the transformed variables.

Although the  $r$  and  $r^2$  values are strong, .946 and .894 respectively, the residual plot displays a quadratic pattern, leading us to believe that a logarithmic transformation of this linear regression is not appropriate, and that an alternative transformation may be more appropriate.

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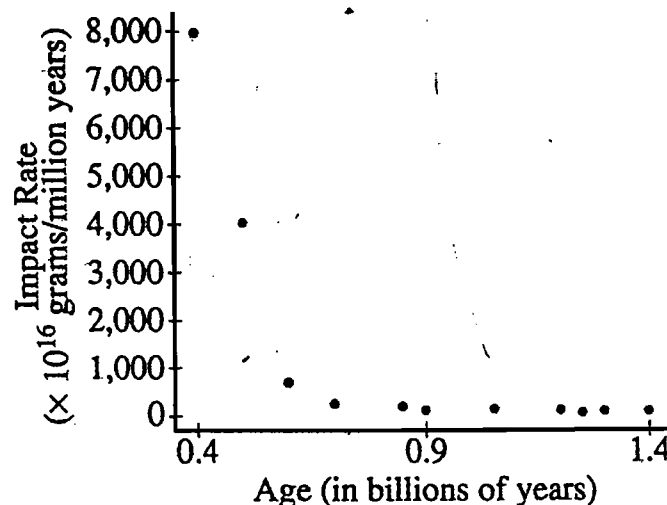
STATISTICS  
SECTION II  
Part A  
Questions 1-5

B<sub>1</sub>

Spend about 65 minutes on this part of the exam.  
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**Directions:** Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. The Earth's Moon has many impact craters that were created when the inner solar system was subjected to heavy bombardment of small celestial bodies. Scientists studied 11 impact craters on the Moon to determine whether there was any relationship between the age of the craters (based on radioactive dating of lunar rocks) and the impact rate (as deduced from the density of the craters). The data are displayed in the scatterplot below.



- (a) Describe the nature of the relationship between impact rate and age.

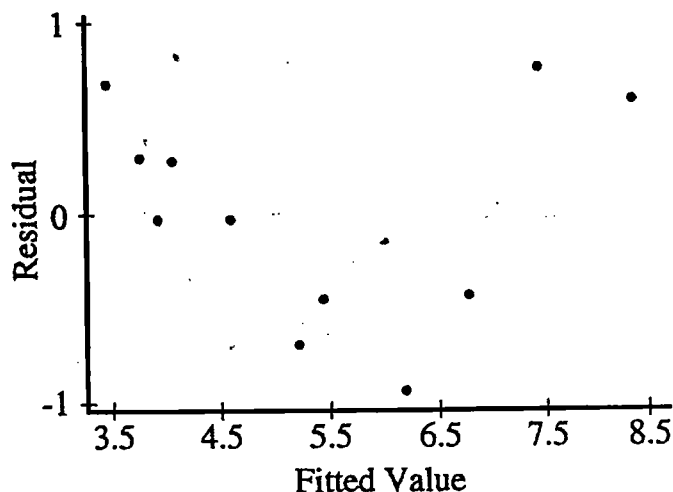
The relationship between impact rate and age seems to be negative. The data points plotted look like a straight line for the ones that have a low impact rate but age is increasing for these points. There is a moderate correlation between the data points.

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Prior to fitting a linear regression model, the researchers transformed both impact rate and age by using logarithms. The following computer output and residual plot were produced.

B<sub>2</sub>

Regression Equation: $\ln(\text{rate}) = 4.82 - 3.92 \ln(\text{age})$				
Predictor	Coef	SE Coef	T	P
Constant	4.8247	0.1931	24.98	0.000
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S = 0.5977		R-Sq = 89.4%	R-Sq (adj) = 88.2%	



(b) Interpret the value of  $r^2$ .

$R^2$  states that 89.4% of the variability in logarithms of rate is accounted for by the variability in the logarithms of age.

(c) Comment on the appropriateness of this linear regression for modeling the relationship between the transformed variables.

The  $r$  for this model is .946 which is a pretty strong correlation however the residuals show a curved pattern which indicates that the data needs to be transformed. Hence, this model is not really appropriate for modelling the relationship between the transformed variables.

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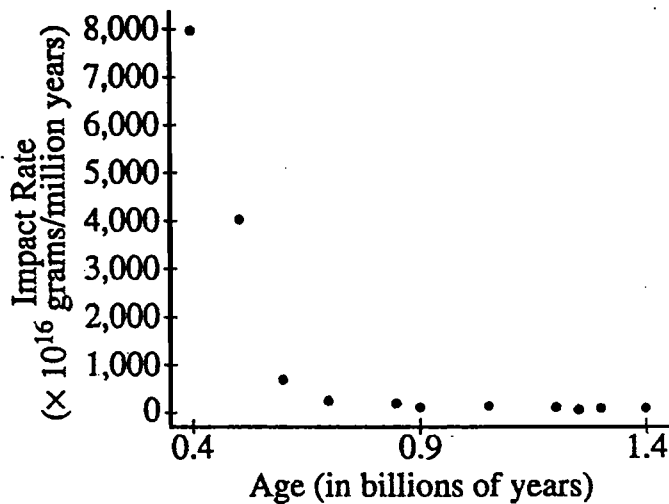
C<sub>1</sub>

STATISTICS  
SECTION II  
Part A  
Questions 1-5

Spend about 65 minutes on this part of the exam.  
Percent of Section II grade—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy of your results and explanation.

1. The Earth's Moon has many impact craters that were created when the inner solar system was subjected to heavy bombardment of small celestial bodies. Scientists studied 11 impact craters on the Moon to determine whether there was any relationship between the age of the craters (based on radioactive dating of lunar rocks) and the impact rate (as deduced from the density of the craters). The data are displayed in the scatterplot below.



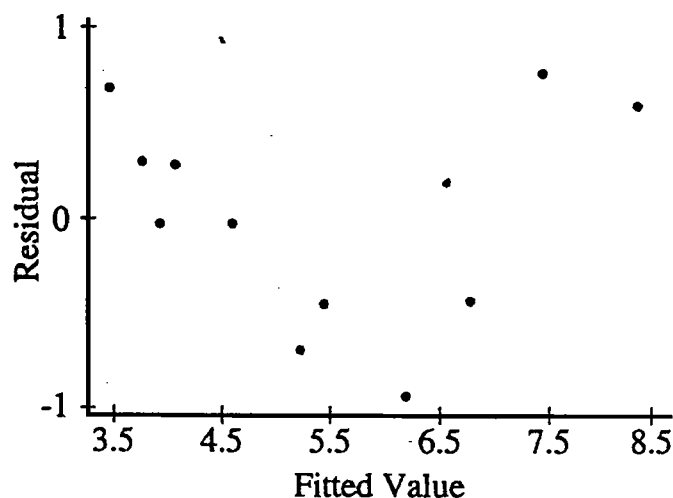
- (a) Describe the nature of the relationship between impact rate and age.

Impact rate and age are negatively associated.  
When the age increases, impact rate decreases.  
The relationship is moderately strong and negative.  
But actually the association is not really linear; there's a curvature in the pattern, also there are two obvious outliers.

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S = 0.5977		R-Sq = 89.4%		R-Sq (adj) = 88.2%



(b) Interpret the value of  $r^2$ .

89.4% of the variability in impact rate is accounted for by the variability in age.

(c) Comment on the appropriateness of this linear regression for modeling the relationship between the transformed variables.

When we look at the residual plot above, we see that there's a curvature in the residual plot. In order to use a linear regression equation, we shouldn't have curves in our residual plot. Therefore I think that linear regression is not really appropriate because of that curvature in the residual plot.

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