AP Statistics Ch 10 - Extra Practice **Name:** Solutions **Per:** ____

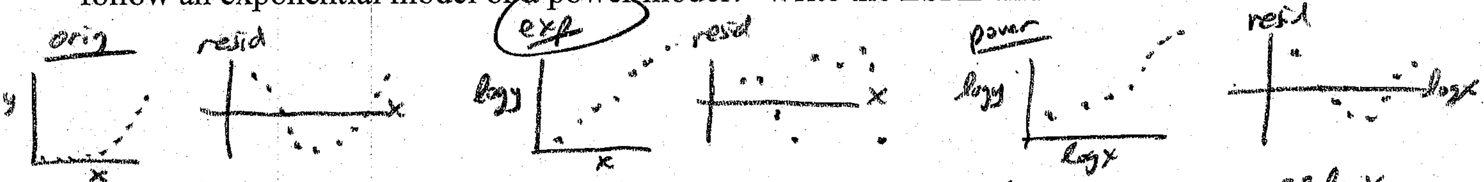
Is Pluto a Planet?

	Position Number	Distance from Sun (million miles)	Length of Year (earth years)
Mercury	1	36	0.24
Venus	2	67	0.61
Earth	3	93	1.00
Mars	4	142	1.88
Jupiter	5	484	11.86
Saturn	6	887	29.46
Uranus	7	1784	84.07
Neptune	8	2796	164.82
Pluto	9	3666	247.68

#1. Enter the position number into L1 and the distance from the sun into L2. If you were to fit a linear model to this data, what you expect to see in the residuals?

a very pronounced curve.

#2. Straighten the data and fit a linear model to the straightened data. Does the original data follow an exponential model or ~~a power~~ model? Write the LSRL and r^2 for the best model.



$\hat{y} = -1130.06 + 447.23x$ $r^2 = .8286$

$\log \hat{y} = 1.2452 + .2709x$ $r^2 = .98151$

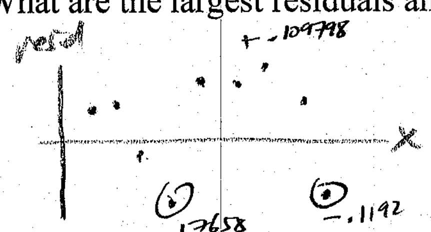
$\log \hat{y} = 1.205 + 2.2598 \log x$ $r^2 = .887$

Exponential: $\log \hat{y} = 1.2452 + .2709x$ $r^2 = .98151$

#3. Comment on how well your model fits the data (residuals, r^2).

Exponential model is best because it is the only one without a clear pattern in the residuals. It also has a very high $r^2 = .98151$. About 98% of the variation in distance from the sun is explained by the exponential model relating distance from the sun to planet position number.

#4. What are the largest residuals and which planets do they correspond to?



Mars has residual of $-.17658$

Pluto has residual of $-.1192$

#5. Do these residuals indicate actual difference in distance from the sun?

No, because for exponential these are log y values.

#6. Now delete Pluto from L1 and L2. Re-straighten the data and fit a line to the straightened data. Write the LSRL and r^2 for your model.

$\log \hat{y} = 1.20267 + .28368x$

$r^2 = .982526$

#7. Predict how far Pluto should be from the sun, using this model (don't forget to undo the log). Do you think Pluto is a planet according to this result? Why or why not?

$\log(\hat{y}) = 1.20267 + .28368(9)$

$\log_{10}(\hat{y}) = 3.75579$

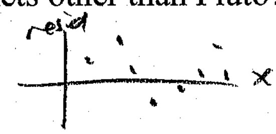
$\hat{y} = 10^{3.75579} = 5699$ million miles

actual $y = 3666$ hmmm maybe not a planet?

#8. The asteroid belt between Mars and Jupiter may be the remnants of a failed planet. If so, Jupiter is in position 6, Saturn is in 7 and so on. Re-number the planets but leave Pluto out of the list, and re-straighten the data, then re-fit your model and write down the LSRL and r^2 for your model. Is this a better model for the planets other than Pluto?

$\log(\hat{y}) = 1.2852 + .2388x$

$r^2 = .9947$



Yes, residuals are still random, and r^2 is higher.

#9. With this latest model, predict how far Pluto should be from the sun. Now, do you think Pluto is a planet?

$\log(\hat{y}) = 1.2852 + .2388(10)$

$\log_{10}(\hat{y}) = 3.6732$

$\hat{y} = 10^{3.6732} = 4712$

$(y = 3666)$

Not sure. Predicted & actual are closer than before, though.

#10. Go back to the original planet data (no asteroid belt, and leave Pluto removed). (The LSRL for this data is your answer for #6.) In 2002, astronomers discovered a new large body that could possibly be a planet, called Quaoar. Quaoar is about 4 billion (4000 million miles) from the sun. do you think it's a better candidate for the 9th planet than Pluto? Why or why not?

$\log(\hat{y}) = 1.20267 + .28368(9)$

$\log(\hat{y}) = 3.75579$

$\hat{y} = 10^{3.75579} = 5699$ predicted

Pluto: 3666

Quaoar: 4000

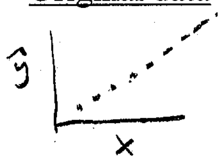
Quaoar is closer to the predicted distance for a 9th planet than Pluto. (Not sure this is the only, or best, criterion for determining planet status, though :))

#11. **World Population**

(a) Straighten the data shown in the table. Does the data follow an exponential or power model (check original data and both models)? Write out the LSRL and justify your decision (you must use residual plots).

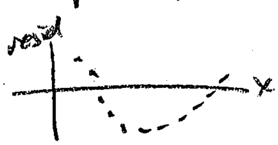
Year	Population (millions)
1950	2519
1955	2755
1960	3020
1965	3334
1970	3691
1975	4066
1980	4430
1985	4825
1990	5255
1995	5662
2000	6057

Original data

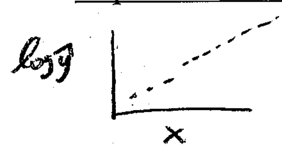


$\hat{y} = -138570 + 72,2618x$

$r^2 = ,994147$

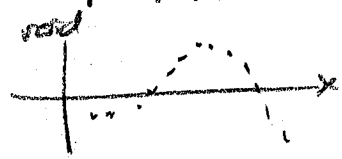


Exponential Model

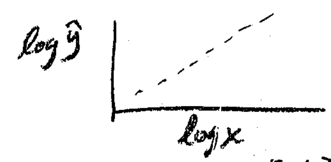


$\log \hat{y} = -11,7633 + ,007779x$

$r^2 = ,9974$

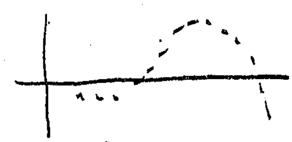


Power Model



$\log \hat{y} = -112,998 + 35,3806x$

$r^2 = ,9977568$



Best LSRL: $\log \hat{y} = -112,998 + 35,3806x$

None are good (sometimes straightening just doesn't work)

we'll pick power (highest r^2)

(b) Using the best model, find the predicted world population for 2005.

$\log \hat{y} = -112,998 + 35,3806 \log(2005)$

$\log_{10}(\hat{y}) = 3,8327...$

$\hat{y} = 10^{3.8327...} = $ **6804 million people**