

NAME:

Key

MATH 1470 Fall 2005 Tintera

TEST 2: Malthus, Demographic Transition and Logistic Models. Covers Chapters 5-6

You may use calculators and one 8.5 by 11 inch page of handwritten notes. Please show all work on this test booklet. Partial credit is awarded only for work shown. Each problem is worth as indicated. Good luck!

For the first four questions, choose the best answer by circling the letter for that answer. (5 points each)

1. Which of the following correctly relate Malthus' terminology to modern terminology:
 - A. Arithmetic growth is the same as logistic growth.
 - B. Geometric growth is the same as linear growth.
 - C. Arithmetic growth is the same as linear growth.
 - D. Arithmetic growth is the same as exponential growth.

2. Which of the following is NOT true about moving averages?
 - A. They are a technique for smoothing out jittery data.
 - B. They replace an entire data set rather than just a single value.
 - C. They can be either centered or trailing.
 - D. They compare data to a fixed base.

3. Which of the following IS true about demographic transitions:
 - A. Birth rates fall in a country before the death rates.
 - B. The growth rates fall and then rise.
 - C. The birth rate falls as a result of prosperity.
 - D. The death rate rises as a result of industrialization.

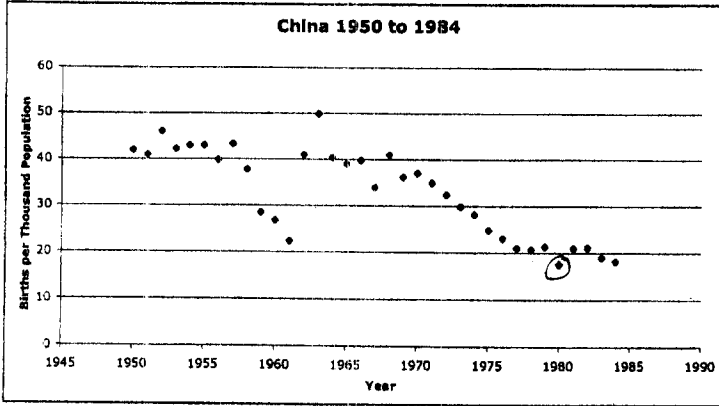
4. Which of the following is NOT a characteristic of a logistic model?
 - A. There is early exponential growth.
 - B. The change, Δy , will be negative if y exceeds the carrying capacity.
 - C. The rate of change of y is greatest when y is close to half of the carrying capacity.
 - D. The graph has a characteristic "R" shape.

5. Label each of the social conditions with the stage of a demographic transition they would be typically be found in. (1 point each)

| Condition | Stage |
|---|-------|
| A shift from agricultural to industrial activity. | 2 |
| Women have higher levels of education. | 3 |
| Children become an economic liability instead of an economic asset. | 3 |
| A better food supply and more medical care translate into a lower death rate. | 2 |
| A high birth rate is more or less offset by a high death rate. | 1 |

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6. Below is a graph of the birth rates in China from 1950 to 1984.



a) (5 points) Estimate the birth rate in China in 1980 and express that birth rate as a percentage:

b) Based on the birth rate alone, give your best guess as to the stage of a demographic transition that China was in in 1985. Be sure that your answer shows me that you understand what a demographic transition is. (10 points)

Birth rate in 1980: 17.5 → 1.75%

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Stage III because the birth rates are family consistent. Here, in Stage III, even though it's illustrated on the graph, death rate stays low, and the growth rate continues at a slower pace, while birth rate falls as it becomes consistent. Looks like the birth rate began to fall in 1970 until 1977. This decline suggests the onset of Stage III. The factors that cause Stage III include further increases in economic development, and required levels of education in post-industrialized societies.

7. The following data is about the population and food production in Poland:

| Year | Population | Food | $\Delta pop.$ |
|------|------------|-------|---------------|
| 1962 | 30,419 | 64.8 | 4% |
| 1966 | 31,478 | 75.9 | 264.75 |
| 1970 | 32,526 | 78.9 | 194.50 |
| 1974 | 33,706 | 88.3 | 295.00 |
| 1978 | 34,938 | 94.6 | 302.00 |
| 1982 | 36,259 | 85.6 | 330.25 |
| 1986 | 37,446 | 101 | 627.00 |
| 1990 | 38,119 | 102.4 | 166.25 |

Does the population growth in Poland match what Malthus said about population in general? Be clear about what he said, what you see and your conclusion. (10 points)

According to Malthus' population model, population should increase at a rate faster than "doubling itself every twenty-five years." If this data were to support this statement, Poland's population would have to be somewhere in the vicinity of 61,400. However, the data shows that the population has only increased by approximately 7,650 in the past 25 years. Therefore, the data given above does not support Malthus' population model.

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8. The number, x , of feral cats on Ward Island seems to be governed by a the logistic model:

$$\frac{\Delta x}{\Delta t} = 0.03x - 0.0005x^2$$

a) (5 pts) Find the maximum number of feral cats on Ward Island predicted by the model.

$$L = \frac{a}{b}$$

$$L = \frac{0.03}{0.0005}$$

$$L = 60$$

b) (5 pts) If there were 10 feral cats on Ward Island one year, how many would there be the next year?

$$= 10 + 0.03(10) - 0.0005(10)^2$$

$$= 10.30 - .05$$

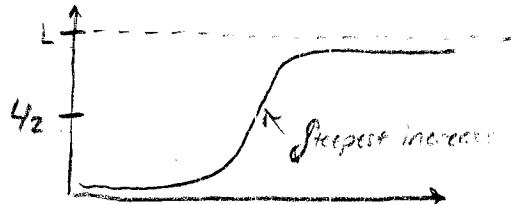
$$= 10.25$$

c) (5 pts) When would there be the greatest increase in the Ward Island feral cat population?

$$x = L/2$$

$$x = 60/2$$

$$x = 30$$



9. The percentage of students in a modeling course who had completed a reading quiz grew at a relative growth rate of 12% per day but leveled off with 85 percent of the students completing the reading quiz.

Either write a logistic model for this situation (being sure to explicitly defining the variables used) or explain why it would not be appropriate to use one. (10 points)

$$\frac{\Delta y}{\Delta t} = .12 \cdot y \cdot \left(1 - \frac{y}{\frac{85\%}{100}}\right)$$

Value will not allow appropriate logistic model / 85?

I don't think that this situation would allow a proper logistic model to be formed mainly because of the (85 percent) value. This value represents the carrying capacity, however, I don't think it's in the correct format. I feel that the value should be much larger. I was thinking that maybe the value could be multiplied by 100 to make it as a decimal form number, but I didn't think that was correct. Thus, a logistic model would not be appropriate for this situation.

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.12 → early exponential growth rate ✓

y = percentage of students who completed the reading quiz ✓

t = time (in days) ✓

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10. Below is a spreadsheet of the population and food supply for Mexico for the years given.

| | A | B | C | D | E | F | G |
|---|------|-------------|-----------------|----------------------------------|-----------------|---------------------------|------------------------|
| 1 | Year | Mexico Pop. | Corn Production | 3 Yr Trailing Mvg Avg—Population | Per Capita Corn | Indexed Pop (Base = 1991) | Annual %Growth in Corn |
| 2 | 1986 | 77,015 | 11,910 | | ? | | |
| 3 | 1987 | 78,561 | 11,607 | | | | |
| 4 | 1988 | 80,109 | 10,592 | ? | | | |
| 5 | 1989 | 81,663 | 10,953 | | | | ? |
| 6 | 1990 | 83,226 | 14,635 | | | | |
| 7 | 1991 | 84,801 | 14,251 | | | | |
| 8 | 1992 | 86,386 | 16,929 | | | ? | |

a) For each of the cells below, show the formulas as they would be entered into an Excel spreadsheet. Where appropriate, put \$ signs to indicate values that don't change. (5 points each)

D4: =average(C4:C2) ✓

E2: = B2/C2 ✓

F8: = 100*(B8/B\$7) ✓

G5: = (C5-C4)/C4 ✓

b) Into which cells in the table above could the formula in cell D4 be copied? You should assume that row 8 is the last row in the table. (5 points)

D4 through D8 ✓