Name:

Practice Problems

1. Using the given pyramid of energy flow, calculate the amount of energy that moves through each trophic level. Start with the first trophic level grass at 100,000 kcals. How much energy moves to the second trophic level (primary consumer) rabbits? Use the chart below to fill in your answers. Once you calculate the amount of energy transferred to the rabbits, move on and calculate how much energy moves to the foxes and finally to the hawks. See the table below to calculate the amount of energy for each level.



Table showing the transfer of energy through each trophic level

|  |  |  |
| --- | --- | --- |
| Between trophic levels | Percentage of energy efficiency | Energy in kcals that moves to the next trophic level? |
|  |  | Calculation | Rounded answer |
| Grass to Rabbits | 12% energy efficiency |  |  |
| Rabbits to Foxes | 14% energy efficiency |  |  |
| Foxes to Hawks | 8% energy efficiency |  |  |

**Doubling Time and the Rule of 70**

The doubling time or Rule of 70 is a useful tool for calculating the time it will take for a population (or money) to double. The rule of 70 explains the time periods involved in exponential growth at a constant rate. To find the approximate doubling time of a quantity growing at a given annual percentage, such as 10%, divide 70 by the percentage growth rate. Remember, the Rule of 70 is an approximation, the actual Rule is 69.3.

So the doubling time for the $1000 investment with an annual percentage rate of 10% is

70/10 = 7 years

The actual Rule of 69.3 is

69.3/10 = 6.93 years

When asking students to calculate the doubling rate, the question will probably ask for an approximate value.

Here is an example of a similar AP multiple-choice question that asks student to calculate doubling time using the Rule of 70.

2. If the population of rabbits in an ecosystem grows at a rate of approximately 4 percent per year, the number of years required for the rabbit population to double is closest to

a. 4 years b. 8 years c. 12 years

d. 17 years e. 25 years

3. A population of moose numbers 2000 in the year 2000. Based on its growth rate (r ), its population is predicted to grow 4000 by the year 2035. What is the rate of growth of the moose population during this time period?

4. A colony of Ameba is growing in a beaker at the rate of 10% per hour. The initial population size is 800. Assuming a carrying capacity of 900, what is the population size at the end of the first hour?

5. A population of ground squirrels has an annual per capita birth rate of 0.06 and an annual per capita death rate of 0.02. Estimate the number of individuals added to (or lost from) a population of 1,000 individuals in one year.

1. 120 individuals added
2. 40 individuals added
3. 20 individuals added
4. 400 individuals added
5. 20 individuals lost

6. At the start of a study there were 200 spotted salamanders in an old-growth forest patch in western Oregon. Over the next year a biologist tracking the salamanders saw that 25 new salamanders hatched and 5 died. Thus r for this year was

1. 0.1
2. 5
3. 20
4. 25
5. 200

7. The population size in a city called Industria was 2.5 million in 1895. Determine what the population size of Industria would have been in 1951 if the population had continued to grow at the annual rate of growth recorded for industria in 1895 (2.5%).

8. In a corn field in Iowa in the summer, the Gross Productivity is 150 g/m2/day, and the respiration loss is 25%. One gram of corn is equivalent to 2000 calories. The insolation energy is 500 calories/cm2/day. Find the efficiency of photosynthesis.

9. In a light bottle-dark bottle Winkler lab measuring dissolved oxygen in water (DO), the light bottle contained 11mg of oxygen per liter and the initial bottle contained 6mg of oxygen per liter. The dark bottle contained 2mg of oxygen per liter.

1. In mg oxygen per liter, what is the Net Primary Productivity (NPP) for this Light Bottle-Dark Bottle experiment?
2. What is the Gross Productivity (GP) for this experiment?

10. A colony of Stentor (a single-cell, fresh water protistan) is growing in a beaker in the lab at the rate of 1% per hour. The initial population size is 1000, and the carrying capacity of the beaker is 1200. What is the approximate population size at the end of the first hour?

11. A population growing at 10% would double in how many years?

12. At the depth of one meter what is the Net Primary Productivity in the lake?

13. In a cranberry bog in the Cape, the insolation energy is 9,000,000 calories/m2/day. The gross productivity of the cranberry is 0.014g/cm2/day, and the respiration loss is 25%. One gram of cranberry is equivalent to 1000 calories.

a). Calculate the net primary productivity of the cranberries.
b.) Find the efficiency of photosynthesis for the cranberries.

14. In a field of strawberries, the net primary productivity is 140g/m2/day, and the respiration loss is 20%. The insolation energy is 800 calories/cm2/day, and one gram of strawberries is equivalent to 2000 calories.

a.) Find the gross productivity of the strawberries.
b.) Using the net primary productivity, calculate the efficiency of photosynthesis for the strawberries.

15. At the end of 1996 a population numbers 200,000. During 1999, the natality is 1500, mortality is 700 and there are 600 immigrants and 500 emmigrants.

a.) What is the population size at the end of 1999?
b.) In 1999, what was the:
 death rate:
 birth rate:
c.) Calculate r for this population during 1999.
d.) If growth continues at the 1999 rate, what is the doubling time for this population?
(Doubling Time formula is 70/r)

16. On a range of 375 acres are a total of 1450 snowshoe hares. During the following year studies

indicate the rates for this population:

Birthrate – 3625/yr

Mortality – 2320/yr

Immigration – 190/yr

Emigration – 845/yr

a. Is the population of snowshoe hares increasing or decreasing?

b. Calculate the rate at which the population is changing (+ or - # snowshoe hare/yr).

c. Predict the population size at the end of four years.

d. What is likely to happen to the population of producers in this area during the four

years? (BTW, snowshoe hares are herbivores.)

17. In a certain city an 10-block area, 500 houses contained 1630 humans and an estimated

population of 1900 rats. Then the Urban Renewal Commission razed the houses in the area and

constructed 12 large apartment buildings. Following this development, 2550 humans and an

estimated population of 300 rats occupied the area.

a. Calculate the population density per block for rats before and after the development.

b. What is the change in rat population density?