Using the Geometric Distribution

The following problem will be used to practice working with the geometric distribution using the calculator:

A smoothie shop sells on average 80 strawberry, 47 raspberry, and 23 banana smoothies on any given day.

Problems:

a.) What is the probability that the first raspberry smoothie sold on a particular day is the fourth smoothie sold?

b.) What is the probability that the first raspberry smoothie sold on a particular day is the fourth or fifth smoothie sold?

c.) What is the probability that no strawberry smoothie is sold out of the first 5 smoothies bought?

The questions being asked indicate that this is a geometric distribution. The number of smoothies is discrete and smoothies are being purchased repeatedly until a success occurs. In this case, a success means purchasing a raspberry smoothie. The purchases of smoothies are independent of each other and the probability of success is the same for each purchase. The formula for the probability that the first success occurs in trial number x is :

$$P(x) = pq^{x-1}$$

Again, x is the number of the trial in which the first success occurs, p is the probability of success in a single trial. And q is the probability of failure in a single trial (q = 1 - p).

a.) P(4)

The probability of success, that is, selling a raspberry smoothie is

$$p = \frac{47}{150} = 0.313$$

geometpdf(.313,

Now, in the calculator we do the probability of the 4th smoothie sold being a raspberry smoothie P(4). Follow this sequence:

 2nd > **DISTR** > scroll down to **E: geometpdf(** > ENTER > **0.313 , 4)**

(Screen 1)

ENTER

(Screen 2)

geometpdf(.313,▸
             .101487966

The probability of that the first raspberry smoothie sold on a particular day is the fourth smoothie sold is 0.101 (or about 10%).

b.) P(x = 4 or x = 5) = P(4) + P(5)

From part a. we know that p = 0.313. The probability that the first raspberry smoothie sold on a particular day is the fourth or fifth smoothie sold is just the probability of the fourth added to the probability of the fifth(the sum of P(4) and P(5)). So again, we can use the *geometpdf* function in the calculator and add the two probabilities by following the sequence:

metpdf(.313,5)

 2nd > **DIST** > scroll down to **E: geometpdf(** > ENTER > **0.313 , 4)** > **+** > 2nd

 > **DIST** > scroll down to **E: geometpddf(** > ENTER > **0.313 , 5)**

(Screen 3)

ENTER

(Screen 4)

geometpdf(.313,▸
             .1712101987
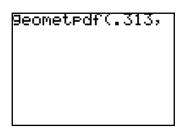
The probability that the first raspberry smoothie sold is the fourth or fifth sold on a particular day is 0.172 (or about 17%).

Note: You could also just add the probability of the fifth to your answer in part a. and you would get the same result.
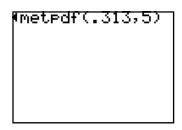
c.)

The probability of success, that is, selling a strawberry smoothie is p = $\frac{80}{150}$ = 0.533.
Since the x - value cannot be within the first 5 smoothies, *x* must be greater than 5. So
we can say that :

$$P(x > 5) = 1 - P(x \leq 5)$$

We can do this on the calculator using the *geometcdf* function in the calculator by fol-
lowing the sequence:

*1 > - > 2nd > **DISTR** > scroll down to **F: geometcdf(** > ENTER > 0.533 , 5)*
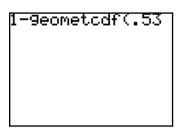
(Screen 5)

ENTER

(Screen 6)

This gives us a probability of 0.022 (or about 2%) that no strawberry smoothie is sold in
the first 5 smoothies bought. This makes sense because the probability should be low
since the probability of selling a strawberry smoothie is a little more than 50%.

NOTE: Anytime when using the calculator, how do you know whether to use the *pdf* function or the *cdf* func-
tion?

Use the ***cdf*** function when you are looking for a sum over a range of values from 0 up to and including a specific
number (less than or equal to).

      Ex. P(x ≤ 10)

Use the ***pdf*** function when you are looking for a single value of x (equality).

      Ex. P(x = 100) = P(100)