Every action is risky to some extent. Most people would consider some activities, such as hang gliding or mountain climbing, quite risky. There are other things that are not commonly thought of as risky, such as driving to school or taking a shower, yet even these carry some risk. The probability of various risks has been calculated, but most of the numbers are so small that many people do not have an intuitive understanding of them. To help better understand these types of probabilities, John and Sean Paling in their book *Up to your Armpits in Alligators? How to Sort Out What Risks Are Worth Worrying About*, devised a logarithmic scale to describe risks. This scale uses common logarithms to convert a probability to a risk number.

Probability of an Event Occurring	Risk Number
1/10	5
1/100	4
1/1000	3
1/10,000	2
1/100,000	1
1/1,000,000	0
1/10,000,000	-1
1/100,000,000	-2
1/1,000,000,000	-3
1/10,000,000,000	-4
1/100,000,000,000	-5

Note that a one in a million chance is assigned a risk number of 0. Events associated with risk numbers below zero are insignificant and should not be of much concern. For example, the Food and Drug Administration is not concerned about the cancer risk from a particular food additive if the risk number is below zero. Even events that have a risk number of 0, +1, or +2 aren't very significant. For events with a risk number above two, however, you should be concerned about possible dangers. For instance, doctors now say that about one in nine women will get breast cancer. This is about a risk of +5.

1. Find a function which expresses risk number r in terms of probability p. It may help to find the Log of each probability in the table above.

   $r = \log p + 6$

2. The following are annual risks for Americans expressed as probabilities.

You will be injured if you play basketball regularly.	1/40
You will die of cancer.	1/500
You will be killed by a tornado.	1/2,000,000
You will contract the plague.	1/25,000,000
You will die of rabies.	1/100,000,000

   (a) Find the risk number for each event. (up to one decimal place)

   Basketball injury $r = 4.4$. Cancer $r = -3.3$. Tornado $r = -0.3$. Plague $r = -1.4$. Rabies $r = -2$

   (b) Find the difference between the risk numbers for being injured playing basketball and dying of cancer. What does the difference in risks numbers tell you?

   The difference is $4.4 - 3.3 = 1.1$ which means there is 1.1 order of magnitude greater risk (factor of $10^{1.1}$) of getting injured playing basketball then dying of cancer.

(c) Find the difference between the risk numbers for being killed by a tornado and contracting the plague. Is the difference between the first two events closer together, about the same, or further apart than the second two? Were you surprised at the comparison using risk numbers?

The difference is $-0.3 - (-1.4) = 1.1$. This difference is about the same, which may seem surprising.

3. The following are annual risks for Americans given as risk numbers.

You will be injured and require immediate medical attention.	+5.5
You will have a fatal accident if you are a skydiver.	+3.0
An asteroid will collide with the earth.	+0.6
The extra risk of cancer from eating a char-broiled steak once a week.	-0.4.
You will die from an airplane crashing on you.	-1.4

(Note: This question was created before September 11th, 2001. Discuss with your group if you feel the last risk factor has now changed.)

(a) Find the probability of each event above. Write your answers in the form: 1 in _____ chance.

Medical attention $p = 10^{-0.5} = 0.316 \Rightarrow$ a one in 3.16 chance. Fatal skydive $p = 10^{-3} = 0.001 \Rightarrow$ a one in 1000 chance. Asteroid $p = 10^{-5.4} = 3.98 \times 10^{-6} \Rightarrow$ a one in 250,000 chance. Cancer from steak $p = 10^{-6.4} = 3.98 \times 10^{-7} \Rightarrow$ a one in 2,500,000 chance. Plane on head $p = 10^{-7.4} = 3.98 \times 10^{-8} \Rightarrow$ a one in 25 million chance.

(b) Use your work above to find an expression for probability as a function of risk number.

$p = 10^{r-6}$