**Exercises for Module #1**

Some of the questions below have definite answers. Others require you to make an informed judgement after understanding the watching/reading materials. Both are important in their own way. Quantitative and qualitative reasoning are important to science in complementary ways.

1.  Scientists are told to doubt everything and not believe anything that is not provable. Is this a strength or weakness of science?

2.  According to the philosopher of science, Sir Karl Popper, even the most well-established and popular scientific theory can never be proved – it can only be disproved. Discuss this strange sounding claim.

3.  Suppose we measure time by using hour glasses filled with sand. Discuss the various errors that would exist if we tried to use this as a world standard for time. Give a rough estimate for the error over a 24 hour period.

4.  Which of the following equations is definitely wrong:
    (a)  $v = at^2$
    (b)  $x = 3at^2 + 4v^2t$
    (c)  $E = \dfrac{mc^2}{\sqrt{1 - \dfrac{v^2}{c^2}}}$
    (d)  $P = \dfrac{E}{c\sqrt{1 - \dfrac{v^2}{c^2}}}$

    In the above $x =$ distance, $t =$ time, $c$ and $v =$ velocity, $a =$ acceleration, $m =$ mass, $E =$ energy, and $P =$ momentum.

5.  Find how much time is needed for a telephone signal to go from your mobile to your friend's mobile across the table. Assume that the relevant geo-stationary satellite (what's that? ask uncle Google if you don't know) is orbiting the earth at a distance of 250 km and that the electronic circuits have a delay of 300 microseconds. Give your answer in microseconds.

6. Physicist Geoffrey West has applied dimensional analysis to some interesting physical situations. Examples taken from his books can be found explained simply in the video by PH that you just saw. In your own words how would you explain to students each of the following?
   a) An ant is stronger than an elephant.
   b) A mouse eats more than a goat.
   c) Why larger animals live longer.


7. Geoffrey West claims in a TED Talk that simple, mathematical laws govern the properties of cities – that wealth, crime rate, walking speed and many other aspects of a city can be deduced from a single number: the city's population.
   a) Summarize his argument in your own words.
   b) What are the strongest points of his argument?
   c) What are the weakest points of his argument?