Foreground Mathematics Task List

(release date: 5.May.2015, Fort Worth Texas)

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#1. Explain how the circumference of the Earth was first calculated.
#2. Explain how to calculate gas mileage.
#3. Explain the role of hexadecimal in computers.
#4. Explain why an elephant's legs are thick, whereas a spider's legs are thin.
#5. Explain how to calculate distance between two points, given the rectangular coordinates of the two points.
#6. Give an illustration of the fact of non-symmetry of percentage change.
#7. 1.001. raised to the power 360 is, as your calculator will show you, approximately 1.43. Explain the method that was developed, hundreds of years ago, for routinely raising numbers to large powers. Give a reason that 360 is of special interest.
#8. Give the definition of pH.
#9. Explain how to calculate the height of a tall tree.
#10. Explain why determining latitude is easy, and longitude is difficult, and explain how the problem of determining longitude at sea was finally solved.
#11. Explain how absolute zero was computed very easily by means of a straight line crossing the horizontal axis.
#12. Explain how a helix is generated, and explain the significance of a double helix.
#13. Explain the method traditionally used in Accounting to check for transposed digits.
#14. Explain the relevance of the geometric mean to the description of fund performance, and give an easy method for computing the geometric mean of an arbitrary set of (positive) numbers.
#15. Explain how to find the centroid of a concrete wall that has holes in it for windows and a door, and why it is useful to do so.
#16. Explain how to calculate the ultimate ("limiting") height of a tree.
#17. Give an example of a sawtooth pattern arising from traffic.
#18. A coin is tossed two times. What is the probability that it shows heads at least once?
#19. Show that for 23 randomly selected people, the chance is greater than 50% that at least two have the same birthday.
#20. Describe De Mere's paradox, and explain its resolution.
#21. Explain how and why a searchlight uses a mirror that is parabolic in shape, and, how and why a TV satellite dish uses a parabolic shape for reception, and how and why a telescope might be designed to use a parabolic mirror.
#22. Explain what a whispering room is, and how it works.
#23. Show how to calculate the monthly mortgage payment on a house.
#24. Show how to compare two revenue streams.
#25. Show a quick pencil-and-paper way of estimating (1.001) raised to the power 360.
#26. Explain how any quantity, regardless of its dimension, can be represented as an area. In particular, show that distance of travel can be represented as an area.
#27. Prove that a square is the rectangle of greatest area for a given perimeter.
#28. Prove that a square has the smallest perimeter for a given area.
#29. A brick is dropped from a height of 16 feet. How long will it take to reach the ground, given that the acceleration due to gravitation is 32 ft/sec^2?

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#30. At what angle should a cannon ball be fired so that it will travel the greatest distance (with respect to the ground)?
#31. What is the longest stick that can be carried by water around a given corner?
#32. Find the maximum volume that a right circular cylinder can have, such that it surface area, including its two ends, is a given constant.
#33. Air is being pumped into a spherical balloon. Express the rate of change of the radius of the balloon in terms of the rate of change of its volume. For the special case in which the rate at which air is being pumped into the balloon is a (positive) constant, obtain a formula that gives the rate of change of the radius when the diameter is a given value.
#34. A straight stick is leaning against a vertical wall. Express the rate at which the top end is moving down the wall in terms of the rate at which the the bottom end is moving away from the wall, given that the stick is always touching the wall at the highest point it can, given the position of the bottom end. For the special case in which the rate at which the bottom end is moving away from the wall is a (positive) constant, obtain a formula that gives the rate at which the top end is moving down the wall when the top end is at a given height on the wall.
#35. Explain how petroleum exploration once was done using a pendulum.
#36. Determine how much a dollar grows to, at a given APR, after a given amount of time of continuous compounding of the interest.
#37. Explain and derive Newton's Law of Cooling.
#38. Show how to tell the concentration in a continuous-flow stirred tank reactor (CSTR) at any given time.
#39. Derive the formula for the volume (V) of a sphere, and the formula for the surface area (S) of a sphere. Explain the relevance of the S/V ratio for cellular biology, dust explosions, and the behavior of the Sun, and the thickness of legs.
#40. The strength of light and gravitation diminishes inversely with the square of the distance from its source. Give a (strong) plausibility argument for this.
#41. Show how to tell the amount of current in a Direct Current circuit at any given time, and after the battery is removed.
#42. Explain what escape velocity is, and derive the formula for it. Explain its special significance for the Moon.
#43. The curve defined by a string hanging between two poles (such as a telephone wire hanging between two telephone poles) is called a catenary. Derive the formula for the catenary, from first principles.
#44. Prove Kepler's three laws, from Newton's laws of motion and law of universal gravitation.
#45. State, and solve, the two-body problem.
#46. Derive the equation of motion of the spherical pendulum.
#47. Show that the Black-Scholes/Merton option-pricing formula is also the solution to the heat equation.

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