2^7 Nerd Disses:

A Significant Quantity of Disrespect

DUMMIES

SUCKAS

YOU

OWN-O-MATIC

by
Phil Plait, Ph.D. and Zach Weinersmith
Illustrations by Jess Fink

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Acknowledgments

Dear Reader,

If you're like us, you've faced trouble from bullies. For example, I was once pinned down by a young lad who repeatedly asked me why I was hitting myself, when he knew full well that I had temporarily ceded hegemony over my hands and forearms. I tried to explain it to him, but he didn't seem to comprehend.

In retrospect, I can only conclude that my explanation was not articulate enough.

To that end, Phil Plait and I have teamed up to create precisely 2^7 insults designed to weaken the resolve of aggressors, while educating them in their primary field of interest. Whether the person pummeling you is a student of mathematics or belles-lettres, we have the right words for the occasion.

Zach Weinersmith

PS: In the highly likely situation that the person pummeling you refuses to cease his aggression until he understands the meaning of the insult, we have also provided an appendix in which the insults are explained.

Phil convinces Zach to let him in on writing the book.

ASTRONOMY

1) You're so dense... A high iron diet causes you to supernova.

2) You're so scientifically illiterate... You think a torus is your star sign.

Astrology is BULL.

3) You're so dense... You have a Schwarzschild radius.

4) You're so dense... Your clothes keep disintegrating because they're inside your Roche limit.

5) You're so scientifically illiterate... You think bipolar outflow is what happens after a night drinking too much tequila.

6) You're so dense... You and the moon have a Lagrange Point.

7) You're so scientifically illiterate... You think spectral dispersion is what ghost hunters do.

8) You're so scientifically illiterate... You think Trojan asteroids are a venereal disease.

9) You're so scientifically illiterate... You think your love life exhibits pair-instability.

BIOLOGY

10) You drink so much, biologists use your saliva as a tissue fixative.

11) You're so scientifically illiterate... You think a fibula is a small lie.

It's not lying, it's FRACTURED truth!

12) You're so inbred, your family tree shrinks in both directions.

13) You're so inbred, your family is haplodiploid.

14) You're so scientifically illiterate... You think a gamete is meat from a leg.

15) You're so scientifically illiterate... You think a blastula is a vampire zygote.

16) You're so scientifically illiterate... You think a P site is the alley behind a bar.

17) You're so scientifically illiterate... You think an alpha helix is the toughest DNA in a pack.

18) You're so scientifically illiterate... You think angioplasty is an Irish woman.

19) You're so scientifically illiterate... You think dinoflagellates are repenting dinosaurs.

20) You're so scientifically illiterate... You think cerebellum is a war fought over cereal.

21) You're so scientifically illiterate... You think ATP is where an Indian lives.

22) You're so scientifically illiterate... You think macular degeneration is what happens when you eat too much McDonald's.

23) You're so scientifically illiterate... You think gram-negative is when you owe someone crackers.

24) You're so scientifically illiterate... You think helicase is where you put a helicopter.

25) You're so scientifically illiterate... You think homogenized milk comes from gay cows.

26) You're so scientifically illiterate... You think Kingdom Protista are people who oppose monarchy.

27) You're so scientifically illiterate... You think genome is the name of a very short rapper.

28) You're so scientifically illiterate... You think methylation is something you're recovering from.

29) You're so scientifically illiterate... You think monophyly is a boardgame.

30) You're so scientifically illiterate... You think p-chem is for urinalysis.

31) You've got so many varieties of herpes simplex, you're a herpes duplex.

32) You're so scientifically illiterate... You think syngamy is the Italian word for opera.

33) You're so scientifically illiterate... You think mitosis is what you yell when you drop a Petri dish on your foot.
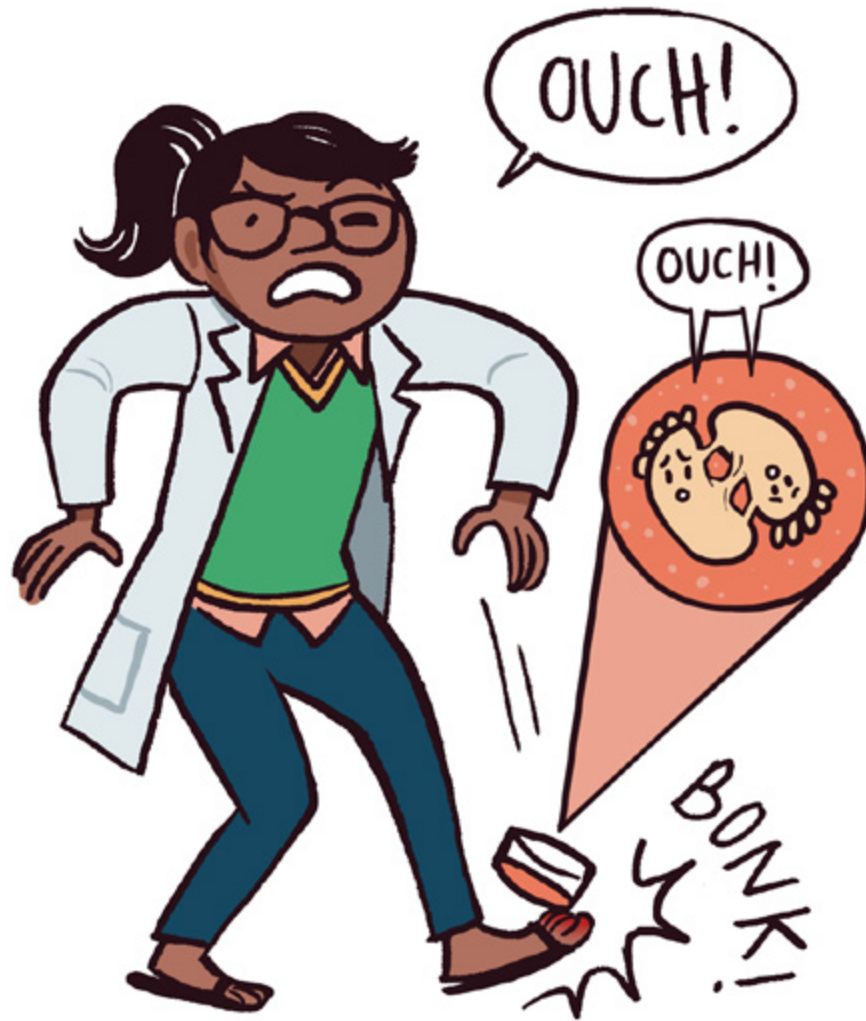
34) You're so scientifically illiterate... You think trisomy X is a good movie rating.

35) You're so scientifically illiterate... You think polydactyly was the name of a parrot.

36) Your skin is so lumpy, the bacteria on it experience allopatric speciation.

CHEMISTRY

37) You're so dense... Osmium looks at you and says, "Dayum!"

38) You're so scientifically illiterate... You think Avogadro's number is how many you need to make a mole of guac.

39) You're so scientifically illiterate... You think a nucleophile is someone who sleeps with bombs.

40) You're so scientifically illiterate... You think annealing is what you do in front of a king.

41) You're so scientifically illiterate... You think ^{56}Ni is $2.80.

42) You're so scientifically illiterate... You think titration is how much milk a baby gets.

43) You're so scientifically illiterate... You think you can neutralize acid by listening to Phish.

44) You're so scientifically illiterate... You think tungsten is how chemists kiss.

45) You're so scientifically illiterate... You think un-ionized is when workers don't have an organization.

ECONOMICS

46) You're so bad at economics, you think doggy style is a positional good.

47) You're so bad at economics, you think Marginal Utility is a description of your life.

48) You're so oily, America is trying to democratize you.

49) You're so bad at economics, you think reserve currency is the fiver you keep in your sock.

50) You're so bad at economics, you think Vilfredo Pareto was a Dr. Seuss character.

GEOGRAPHY

51) You have such a poor grasp of geography... You think Botswana is where robots live.

52) You have such a poor grasp of geography... You think Cape Foulwind is a problem superheroes have.

ew
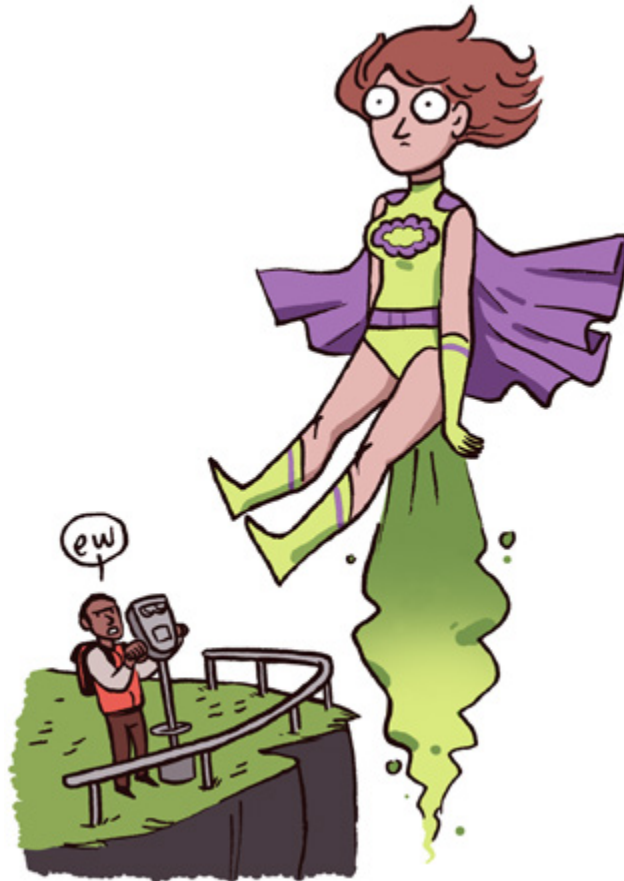
53) You have such a poor grasp of geography... You think a cenote is a hundred dollar bill.

54) You have such a poor grasp of geography... You think Farewell Spit is how most of your dates end.

55) You have such a poor grasp of geography... You think "Indo-Europeans" are people from Amsterdam.

56) You have such a poor grasp of geography... You think Ukraine is a self-service construction company.

57) You have such a poor grasp of geography... You think the Bikini Atoll is when your thong gives you a wedgie.

58) You have such a poor grasp of geography... You think Macedon once roamed the Earth.

59) You have such a poor grasp of geography... You think the Solomon Islands should be split in two.

60) You have such a poor grasp of geography... You think the Moho Layer is the cream filling in a Twinkie.

61) You're like India - subcontinent.

62) You're so historically illiterate... You think Brutus assassinated Popeye.

63) You're so historically illiterate... You think Socrates was killed by headlock.

Justice is the advantage of the STRONGER!

64) You're so historically illiterate... You think Edward Gibbon is a type of monkey.

65) You're so historically illiterate... You think prophylaxis is a guy who fought in the Trojan War.

66) You're so historically illiterate... You think "sic semper tyrannis" was something Stegosaurus said.

67) You're so historically illiterate... You think Sirhan Sirhan was an 80s band.

68) You're so historically illiterate... You think Che Guevara is a French restaurant.

69) You're so historically illiterate... You think the Battle of Salamis was fought over sausage.

70) You're so historically illiterate... You think the fourfold gospel is about how to do Jesus' laundry.

71) You're so historically illiterate... You think the Hundred Years' War lasted a hundred years.

72) You're so historically illiterate... You think the Pact of Steel was between Mussolini and Superman.

73) You're so historically illiterate... You think "Trotsky" is Russian for a way horses walk.

LITERATURE

74) You're so unlettered... You mistake the word malapropism for other similar sounding words.

75) You're so unlettered... You think "Hamlet" is about a small pig.

Alas, poor Francis Bacon!

76) You're so unlettered... You think "Churchillian" is the name of a rodent used to make coats.

77) You're so unlettered... You think a molossus is a giant made of syrup.

78) You're so unlettered... You think polyester is a bird from the Bible.

79) You're so unlettered... You think "pro patria mori" is a TV show where you find out if you're the father.

80) You're so unlettered... You think "The Little Prince" was written by The Little Macchiavelli.

81) You're so unlettered... You use pentameter to measure your inseam.

MATH

82) Your drinks are so high proof, they end with QED.

83) You're so innumerate and vulgar... You think The Kissing Problem has to do with cold sores.

84) You're so innumerate and vulgar... When you integrate around your pole it leaves a residue.

85) You're so innumerate and vulgar... You think discrete math is when you figure how much cash I need to leave on the dresser.

86) You're so innumerate and vulgar... You think "one-to-one" refers to a type of sex you never have.

87) You're so innumerate and vulgar... You think the halting problem has to do with you and bourbon.

88) You're like pi - everyone knows you're irrational, but nobody knows if you're normal.

89) You're so innumerate and vulgar... You think The Probabilistic Method is how you got pregnant.

90) You're so innumerate and vulgar... You think the Wiener Equation is pi · r² · h.

91) You're so innumerate and vulgar... You think topology is the study of the missionary position.

92) You're so innumerate... You think cardinality is determined by the Vatican.

93) You're so innumerate... You think a catenary is a cat who fixes other animals.

94) You're so innumerate... You think a Hamming distance is how far you are from bacon.

95) You're so innumerate... You think an infinite series is how to describe Doctor Who.

96) You're so innumerate... You think an inverse function is a function told in rhyme.

97) You're so innumerate... You think calculus is the math of tooth decay.

98) You're so innumerate... You think cube roots are what topiaries have.

99) You're so innumerate... You think logarithms are songs by lumberjacks.

100) You're so innumerate... You think L'Hopital is where mathematicians go when they're sick.

101) You're so innumerate... You think hyperbolae are the worst things in the history of the Universe.

102) You're so innumerate... You think "Newton's Method" is a euphemism for abstinence.

103) You're so innumerate... You think square roots are a hereditary explanation for your behavior.

104) You're so innumerate... You think the small angle formula explains how many of them can dance on the head of a pin.

105) You're so innumerate... You think transfinites are what Crisco is made out of.

106) You're so superficial you could be a klein bottle.

PHYSICS

107) Your brain is so small... Impacts from Brownian motion give you a headache.

108) You're so dense... Everything you eat is spaghettified.

Huh?

109) Your brain is so small... It has implications for String Theory.

110) Your brain is so small... It can't be described by classical physics.

111) You're so dense... Everything you wear looks red.

112) You're so dense... The rest energy of your body is mc^3.

113) You're so dense... When people hug you, their watches run slower.

114) You're so dense... When you sit around the house, your event horizon sits around the house.

115) You're so dense... When you turn around, your surroundings get torn apart by the Lense-Thirring effect.

116) You're so scientifically illiterate... You think a positron is a happy robot.

117) You're so dense... You have timelike properties.

118) You're so scientifically illiterate... You think absolute zero is diet vodka.

119) You're so scientifically illiterate... You think a galvanometer measures how many women are in a van.

120) You're so scientifically illiterate... You think a neutron is a robot with no testicles.

121) You're so scientifically illiterate... You think Torricelli is a kind of pasta.

122) You're so scientifically illiterate... You think "Weak Interaction" is a description of your sex life.

123) You're so scientifically illiterate... You think a Planck length is something pirates have to walk.

124) You're so dense... You can be used as a neutrino filter.

125) You're so scientifically illiterate... You think dark matter is what you scrape out from under your toenails.

126) You're so scientifically illiterate... You think terminal velocity is how fast a computer runs.

127) You're so scientifically illiterate... You think the First Law of Thermodynamics is "you do not talk about Thermodynamics!"

128) You're so scientifically illiterate... You think the index of refraction is a list of Catholics who broke the rules.

INDEX

Astronomy

1) High-mass stars fuse ever-heavier elements in their cores to generate energy. It takes more energy to fuse iron than iron fusion releases, so when a star gets to that point the core collapses and the star explodes as a supernova.

2) A torus is a geometric shape like a donut. Taurus is the sign of the bull. Much like astrology itself.

3) If you take an object of a given mass and shrink it, its gravity and escape velocity will go up. At a certain size, the gravity will be so strong that the escape velocity becomes the speed of light. The radius of that object—a black hole—is called the Schwarzschild radius.

4) An object near a black hole feels a huge stretching force due to the change in gravity across its size. The distance where that force is so big it tears an object apart is called the Roche limit.

5) Stars sometimes have thick disks around them that can channel jets of material out from both poles; this is called bipolar outflow.

6) When a large mass (like a star or planet) is orbited by a smaller but still significant mass (like a planet or moon), there are places where gravity and other forces will balance, called Lagrange points. An object placed there will stay there unless poked.

7) A prism or grating can break light up into its individual colors, dispersing it into a spectrum.

8) Asteroids that orbit the Sun in the Lagrange points of big planets (see #2) are historically called Trojan asteroids.

9) In some stars, super-high-energy gamma rays can convert into a pair of subatomic particles (an electron and positron). The gamma rays help support the core of the star, but if too many get used up making particle pairs, the core loses stability and collapses. This is called pair instability.

Biology

10) Alcohol is commonly used as a tissue fixative.

11) The fibula is the calf bone.

12) A family tree with no inbreeding should branch out exponentially over time. With inbreeding, the branches... intertwine later.

13) In some species, females all get the same chromosomes from fathers, giving sisters a relatedness of 0.75, as opposed to the 0.5 in species that are not haplodiploid.

14) A gamete is a sex cell. "Gam" is slang for a leg. Meat is that smooshy stuff under your skin.

15) A blastula is an early stage in embryonic development.

16) A P-site is a binding site inside a ribosome, for tRNA.

17) An alpha helix is a right-handed coil of proteins, stabilized by hydrogen bonds.

18) An angioplasty is a medical procedure in which a small balloon is passed through a clogged artery to improve blood flow. If you've ever eaten Irish cuisine, you may need one.

19) Dinoflagellates are microscopic protists with tiny whips (flagellae) used for locomotion.

20) The cerebellum is a part of the brain pertaining to motion, balance, and other functions. "Bellum" is Latin for war.

21) ATP (adenosine-5' triphosphate) is a molecule used to transfer chemical energy in all life.

Biology (continued)

22) Macular degeneration is an impairment of vision due to retinal damage.

23) Gram negative bacteria do not retain the dye used during a process called Gram staining because of a characteristic of their cell walls.

24) Helicase is an enzyme that unwinds nucleic acids.

25) Homogenization is a process that makes a fluid or mixture the same (homogenous) throughout. For milk, this ensures the fat content is the same everywhere in a large batch.

26) Protists are microscopic mutli-cellular organisms, and in biological taxonomy have their own level called a Kingdom.

27) A genome is the genetic hereditary information of an organism stored in DNA (or RNA for viruses).

28) Methylation is the attachment of a methyl group to a molecule, such as DNA.

29) A monophyletic group is a group of organisms that share a common ancestor.

30) P-chem is shorthand slang for physical chemistry.

31) Herpes simplex is the complete name of the disease category commonly called "herpes."

32) Syngamy is another word for fertilization.

33) Mitosis is the part of the cellular division process when chromosomes are duplicated in the nucleus.

34) Trisomy X is when a human female has an extra X chromosome.

Biology (continued)

35) Polydactyly is the condition of having extra (supernumerary) fingers or toes.

36) Allopatric speciation is a form of divergent evolution caused when members of a single species becomes separated by geography.

Chemistry

37) Osmium is the densest of all the natural elements (22.6 grams per cc).

38) Avogadro's number (6.02×10^{23}) is how many atoms (or molecules or other basic constituent) there are in a unit of measurement called a mole of that substance. It is technically defined as the number of atoms in 12 grams of Carbon-12.

39) A nucleophilic atom or molecule has an affinity for positive charge.

40) Annealing has several meanings, but generally refers to the alteration of something's structure by increasing then reducing temperature.

41) ^{56}Ni is a radioactive isotope of nickel.

42) Titration is a chemical process used to determine how much of a constituent is dissolved in a liquid.

43) Acids are normally neutralized with bases. Acid, in the sense of LSD, sometimes leads to bad experiences, which can in some cases be ameliorated by improving mood.

44) Tungsten is a chemical element.

45) An atom that has lost or gained electrons is said to be ionized. An atom that has the same number of electrons around it as the number of protons in its nucleus is therefore said to be un-ionized.

Econ/Political Economy

46) A positional good is a good whose value is determined in reference to some other good.

47) Marginal utility refers to the fact that the utility of a good changes with the consumption of that good. That is, each time Phil consumes a twinkie, he sees twinkies as having lower utility. [N.B. I do not like Twinkies. - PP] [N.B. Phil's initials are "PP." Ha! -ZW]

48) America has a reputation of being more interested in countries that have large amounts of accessible fossil fuel reserves.

49) A reserve currency is a currency that many nations keep in large quantities, often due to its perceived stability.

50) Vilfredo Pareto was an economist during the late 19th and early 20th century, who is best remembered for the concept of "Pareto Efficiency."

Geography

51) Botswana is a republic in southern Africa.

52) Cape Foulwind is a cape on the Southern Island of New Zealand.

53) A cenote is a large, natural, and generally circular sinkhole. A "C-note" is a slang term for a one hundred dollar bill ("C" being the Roman numeral for 100).

54) Farewell Spit is a spit on the Southern Island of New Zealand.

55) "Indo-european" is a major language family. "Indo" is slang for marijuana.

56) Ukraine is an eastern European country.

57) The Bikini Atoll is an island chain in the south Pacific that was the site of nearly two dozen early nuclear bomb tests.

58) Macedon was an ancient Greek kingdom.

59) The Solomon Islands are an archipelago in the southern Pacific. King Solomon was fabled to have solved a child claim dispute between two women by declaring the baby should be cut in half.

60) The Moho (short for **Mohorovičić**) Layer is the boundary between the Earth's crust and mantle.

61) India (together with Pakistan and Bangladesh) is a geographically distinct region of the southern Asian continent.

History

62) Brutus assassinated Julius Caesar. Bluto never assassinated Popeye.

63) Socrates died by drinking a poisonous mixture made from the hemlock plant.

64) Edward Gibbon wrote "The History of the Decline and Fall of the Roman Empire." A gibbon is a species of primate.

65) Prophylaxis is a medical term for a preventative or protective measure.

66) "Sic semper tyrannis"—famously yelled by John Wilkes Booth as he assassinated Abraham Lincoln—is Latin for "Thus always to tyrants".

67) Sirhan Sirhan assassinated U.S. Senator Robert F. Kennedy in 1968. Duran Duran is the name of an 80s rock band.

68) Che Guevara helped lead the Cuban Revolution.

69) The Battle of Salamis was an important naval battle during the Second Persian Invasion of Greece. It is not pronounced like the sausage. Dammit.

70) The "Fourfold Gospel" refers to the canonical inclusion of four gospels in the Bible.

71) The Hundred Years' War was between France and England, and lasted 116 years.

72) The "Pact of Steel" was a 1939 agreement of alliance between Germany and Italy.

73) Leon Trotsky was a Bolshevik leader during the Russian civil war and later opposed Stalin's policies; Stalin had him killed in 1940.

Literature

74) A malapropism is saying one word when you meant to say another similar-sounding word.

75) "Hamlet" is not about a small pig.

76) Churchillian is an adjective meaning "like Winston Churchill." It is not to be confused with the chinchilla, an adorable South American rodent.

77) A molossus is a metrical foot consisting of three long syllables. For example, the phrase "CRAP! CRAP! CRAP!"

78) Polyester, or polyethylene terephthalate, was commonly used as a fabric until Dec 31, 1979.

79) "Pro patria mori" is short for "dulce et decorum est pro patria mori," which is from a poem by Horace, and roughly means "It is sweet and fitting to die for one's country." It was famously referenced in a poem by Wilfred Owen, and has nothing to do with Maury Povich or paternity.

80) "The Little Prince" was written by Antoine de Saint-Exupéry. "The Prince" was written by Machiavelli. "Raspberry Beret" was written by [insert Prince symbol here]

81) Pentameter is a poetic meter consisting of lines with five feet apiece.

Math

82) Mathematical or logical proofs are sometimes finished by writing "QED": "quod erat demonstrandum," which means "which had to be demonstrated".

83) The kissing problem has to do with how many spheres can be packed together, while just barely touching, which is how mathematicians define "kissing."

84) Residue at the pole is a mathematical concept dealing with complex numbers, contour integrals, and singularities, and is also one of the most unfortunately-named ideas in mathematics.

85) Discrete mathematics is the study of discrete mathematical structures (as opposed to continuous ones).

86) A one-to-one function is a function where you never have more than one domain element mapping to the same codomain element. That is, a given input gets a distinct output.

87) The halting problem is a famous problem in computer science, having to do with whether it can be determined in general, whether a program will halt or not without running it.

88) An irrational number is one that cannot be expressed as a simple fraction (like 1/3); a normal number is a non-repeating real number whose digits (0-9) are distributed uniformly throughout. Pi is irrational and thought to be normal, but it's never been proved.

89) The probabilistic method is a technique for proving the existence of a certain kind of mathematical object.

90) Pi · r^2 · h is the area of a cylinder. A cylinder is kind of the shape of a wiener. The actual Wiener Equation has to do with fluid velocity. Make of that what you will.

91) Topology is the mathematical study of shape and space.

Math (continued)

92) Cardinality is the number of elements in a set.

93) A catenary is an arc-shaped mathematical curve, for example the shape of a tensionless string hung between two poles.

94) In computer science, a Hamming distance is the number of changes needed to change from one string to another.

95) An infinite series is the sum of a mathematical sequence with an infinite number of terms (like 1/2 + 1/3 +1/4...).

96) An inverse function is taking a known function for x and solving it instead for y. If F(x) is y = 3x - 4, then the inverse function $F^{-1}(y)$ is x = (y+4)/3.

97) Calculus is the mathematical study of change, but also the term used for tartar or plaque buildup on teeth.

98) Cube roots are the inverse of cubed numbers. The cube root of 27 is 3 (because 3^3 = 27).

99) Logarithms are the inverse of exponents. 10^2 = 100, so the logarithm (in base 10) of 100 is 2.

100) Guillaume de l'Hôpital was a French mathematician, most famous for his method of solving limits.

101) A hyperbola is a mathematical curve. A hyperbolic statement is one that is hugely exaggerated.

102) Newton's Method is a mathematical method of approximating the solution (roots) of a function.

103) Square roots are the inverse of squared numbers. The square root of 64 = ±8.

Math (continued)

104) The small angle formula is a mathematical formulation that says for a small angle, the tangent (and sine) of that angle is equal to the angle's measure in radians. It's useful for getting the physical size of an object when its distance and apparent size is known.

105) Transfinite numbers are numbers that are larger than all finite numbers. Trans fats are what make snack cakes delicious and infinite in lifespan (while thus shortening yours).

106) A Klein bottle is a bizarre three-dimensional closed structure that twists back into itself, creating something that is all surface; it has zero volume (it has no "inside"). If it helps any, when you cut one in half the right way you get two Möbius strips of opposite chirality.

Physics

107) Brownian motion is the random motion of an object suspended in a fluid due to random impacts of atoms or molecules. Notice the extreme amount of discretion we exercised in not making a poop joke with it.

108) Matter falling into a black hole gets stretched out into a long, thin strand due to changing gravitational forces called tides. Astronomers call this process spaghettification.

109) String theory has to do with posited incredibly small one-dimensional "strings" that give rise to all the particles in physics.

110) Very small objects (such as individual atoms or subatomic particles) are better described using quantum mechanics than classical macroscopic mechanics.

111) From the outside, matter falling into a black hole is infinitely redshifted as its light climbs out of the black hole's gravity well.

112) The rest energy of matter (that is, its energy when it's not in relative motion) is described by Einstein's famous equation $E = mc^2$.

113) The gravity of a dense object distorts space and time, such that the watch of someone near the object runs more slowly than one for an outside observer.

114) The event horizon is the region of space near a black hole inside of which light cannot escape; in the simple case of a non-rotating black hole this is a spherical boundary surrounding it where the escape velocity equals the speed of light.

115) Rotating black holes drag the fabric of spacetime around them like a drill bit can be used to stir a glass of milk. This called frame-dragging, or the Lense-Thirring effect.

Physics (continued)

116) A positron is subatomic particle and the antiparticle of an electron. It has the mass of an electron but a positive charge.

117) A closed timelike curve is a region of space where the fabric of space-time is so warped it closes back in on itself, allowing a particle to travel through it and not only back to the point in space where it started, but the point in time as well. Rapidly rotating black holes, theoretically, can create closed timelike curves

118) Absolute zero is the classical (that is, ignoring quantum mechanics) temperature at which all atomic and molecular motion stops—the coldest possible temperature. It is equivalent to about -273° C or -460° F.

119) A galvanometer is a device that measures electric current.

120) A neutron is a kind of subatomic particle with no electric charge
.
121) Evangelista Torricelli was an Italian mathematician and scientist.

122) The weak interaction is one of the four fundamental forces in nature, working on the subatomic scale. It is responsible for how the nuclei of atoms behave, including radioactive decay.

123) A Planck length is the smallest possible distance between two objects due to quantum mechanics; it is literally impossible to measure the distance between two objects that are closer together. A proton is 50 quintillion Planck lengths across.

124) Neutrinos are subatomic particles that interact very weakly with normal matter; they can pass right through the entire Earth without hitting a single particle of normal matter.

Physics (continued)

125) Dark matter is a (so far) unknown type of matter that emits no light and can only interact with normal matter through gravity. It permeates the Universe and is about five times more abundant than normal matter.

126) Terminal velocity is the constant speed at which an object falls once the acceleration due to the force of gravity is balanced by the drag force and buoyancy upward.

127) The First Law of Thermodynamics states that in a closed system, energy is conserved; it is neither created nor destroyed.

128) The index of refraction of a medium (like air or water) determines how much a ray of light is bent when it passes into or out of that medium, and depends on the speed of light in the medium.

ABOUT THE AUTHORS

Phil Plait

Phil Plait is an astronomer, blogger, and frequently seen science documentary talking head.
He writes the Bad Astronomy blog for Slate.com (http://www.slate.com/blogs/bad_astronomy.html) and is the author of two books, "Bad Astronomy", and "Death from the Skies!". Actually, I guess three books now. Someday he hopes to be taller.

Zach Weinersmith

Zach Weinersmith is the creator of Saturday Morning Breakfast Cereal (www.smbc-comics.com), and the Trial of the Clone Gamebook series. He is a little taller than Phil.

ABOUT THE ILLUSTRATOR

Jess Fink

Jess Fink is an illustrator and cartoonist. Her graphic novel,
We Can Fix It! A time travel memoir, is published by TopShelf.
Her adults only Victorian graphic novel Chester 5000 is also
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Her erotic comics have been featured in the anthologies Best
Erotic Comics (Last Gasp,2008) and Smut Peddler
(Iron Circus, 2013) as well as featured at the Museum of Sex
in Manhattan. Her illustration work has been featured in the
New York Times and the North American Review and she has
designed t-shirts and merchandise for Threadless, Hey
Chickadee and Society 6. More of her work can be seen at
JessFink.com. She lives in NY, but she is originally from outer space.