1. **A way of cracking these algorithms involves first finding the modulus of the algorithm, then taking a number of successive outputs, and finally solving the linear system of equations created by those outputs. A test of these algorithms has the goal of measuring the maximum distance between hyperplanes, and is known as the spectral test. Binary rank and birthday spacings are two other tests of these algorithms found in the DIEHARD suite. The (*)** Mersenne twister is an example of this type of algorithm that uses linear recurrence, so it is cryptographically insecure. These algorithms may have a period, or a number of runs before they start repeating their output, and they are necessary to produce salts and one-time pads. For 10 points, name these algorithms that often perform a series of arithmetic operations on a seed in order to return an output that does not contain any statistical patterns.
ANSWER: pseudo**random number generator**s [or pseudo**random data generator**s; or word forms; or P**RNG**s; or **linear congruential generator**s; or **LCG**s; prompt on "**random**ization algorithms" or "**random**ized algorithms"]

2. **This man dismissed Auguste Comte's positivism as "Catholicism minus Christianity." In one essay, this thinker discussed a man named Sergeant F. who would pretend to shoot his cane like a rifle, but was unresponsive to sensory input after a parietal bone fracture. That essay by this man compared the mind to a steam whistle which does not change the motion of a locomotive, and concludes that humans are, like animals, automata. This founder of the X Club debated with (*)** Richard Owen about whether non-human primates have a hippocampus minor, a confrontation later dubbed the Great Hippocampus Question. In one possibly apocryphal incident, this coiner of the term "agnosticism" was asked whether it was through his grandfather or grandmother that he was descended from a monkey. For 10 points, name this thinker whose book *Man's Place in Nature* and participation in a debate with Samuel Wilberforce earned him the moniker "Darwin's Bulldog."
ANSWER: Thomas Henry **Huxley**

3. **Kruskal, Zabusky, and Miura found that this equation has infinitely many integrals of motion. This equation can be generalized to two dimensions by the Kadomtsev–Petviashvili equation, while the Boussinesq equation reduces to this equation in one dimension. Those integrals can be accounted for by using a Sturm–Liouville operator to recast this equation as the Lax equation. This equation can be integrated using the inverse scattering transform of the one-dimensional Schrödinger equation. This equation sets the time derivative of phi plus the (*)** third spatial derivative of phi plus 6 times phi times the spatial derivative of phi equal to zero, and its solutions can be expressed in terms of the Jacobi elliptic functions, or as solitons proportional to hyperbolic secant squared. This equation is the continuum limit for the equation governing the dynamics of the Fermi–Pasta–Ulam experiment. For 10 points, name this doubly eponymous nonlinear partial differential equation used to model waves in shallow water.
ANSWER: **Korteweg–de Vries** equation [or **KdV** equation]

4. **The Tat pathway, which translocates folded proteins across lipid bilayers, functions by recognizing a twin motif of this molecule. A red color indicates the presence of this compound when a solution of 1-naphthol and sodium hypobromite is applied in the Sakaguchi test. A filter consisting of this amino acid and an aromatic amino acid is found in aquaporins. A (*)** vasodilating, gaseous signaling molecule is produced from this compound by the enzyme nitric oxide synthase. An enzyme that cleaves this compound into ornithine and urea in the final step of the urea cycle relies on a manganese ion for activity. Trypsin cleaves on the C-terminal side of residues of lysine or this other basic amino acid. For 10 points, name this amino acid with a guanidinium side chain and symbol R.
ANSWER: **arginine** [accept **Arg** or **R**]

5. **If bash's no-clobber option is on, and one of these things follows a single greater-than-sign, nothing will happen. Linux uses three octals to determine the permissions of these things, which is stored along with other metadata in inodes ("eye-nodes") on the ext3 and ext4 systems and viewable with the LS command. Perhaps the defining philosophy of (*)** UNIX is that it treats everything as one of these things. When interacting with these things when writing a program, one must typically use a namesake "descriptor." SQBS for Windows generates examples of these things without extensions, which is normally used to identify their format. For 10 points, name these stores of information in a drive that can be opened, read, and saved.
ANSWER: **file**s [or **file**systems; or **directories** until "treats everything" is read]

6. **This area was studied by instruments aboard the *Sagar Kanya* in the Indian ocean, which discovered that it creates a barrier for aerosols, such that regions north of it are more than four-fold more polluted than regions south of it. General circulation models that overemphasize sea temperatures in the Southeast Pacific may create a spurious "double" version of this area. Winds that carry energy from the Atlantic's (*)** meridional overturning circulation help push this area further to the north, which supplemented the theory that the shape of coastlines controlled this region's location. Some tropical areas experience monsoons twice a year as this region passes over the ground seasonally, roughly following the sun's zenith point along the thermal equator. Hadley cells carry air towards this region, the rainiest part of the earth. Sailors who were stuck in this band named it the doldrums. For 10 points, name this region located around the equator where the northeast and southeast trade winds meet.
ANSWER: **Intertropical Convergence Zone** [or **ITCZ**; prompt on "**doldrums**" until read; prompt on "**equatorial calms**," "**equatorial belt of calms**," or "**equatorial low** pressure region"]

7. **Weinberg defined the square of this operation as minus one raised to the fermion number, and it is imaginary for Majorana neutrinos. This property is removed by adding a term that goes like F F dual into the Yang–Mills Lagrangian. Steinberger and Chinowsky determined this property of the pion by observing the decay of an atom composed of deuterium and a negatively charged pion. Applying this operation will turn a proper Lorentz transformation to an improper one but won't affect whether it's orthochronous. The fact that two decays of what looked like the same particle had final states with different values for this property was the crux of the (*)** tau-theta puzzle. Pseudoscalars change sign under this operation. Chien-Shung Wu found that the conservation of this property was violated by the weak interaction. For 10 points, name this operation, corresponding to the change in sign of a spatial coordinate.
ANSWER: **p**arity symmetry [prompt on "**CP** symmetry"]

8. **Fluid mediated carbonate mineral removal and silicate mineral precipitation is a proposed mechanism for the release of carbon dioxide in these regions. Fluid-fluxed melting is initiated by the dehydration of antigorite serpentine in these regions. Blueschist indicates the former existence of these regions within continental interiors. When isostatic equilibrium is not observed in these regions, outer trench swelling occurs. Upwelling of the asthenosphere and spreading cause the formation of (*)** back-arc basins in these regions. Seismic activity originates from Wadati–Benioff zones located in these regions, which are characterized by high pressure and low temperatures within their accretionary prisms. After slab detachment, ecologization increases the density of lithosphere allowing it to continue to sink in these regions. For 10 points, name these convergent regions that includes one named for the Cascades where one tectonic plate sinks under another plate and into the mantle.
ANSWER: **subduction** zones

9. **Phosphate buffered saline and this compound make up the cell dissociation reagent Versene. NTA is a contaminant that is produced in the industrial synthesis of this molecule, which begins with formaldehyde and hydrogen cyanide as reagents. Heparin or this compound act as anticoagulants for blood samples. The Singer synthesis produces this compound, which turns a solution of analyte and eriochrome black T from blue to purple. (*)** Running buffers for agarose gel electrophoresis usually consist of a solution of three compounds, in which this is the heaviest. This compound, which consists of two amine and four carboxyl groups, is a common titrant for complexometric titrations. For 10 points, name this hexadentate chelating agent that can sequester metal ions.
ANSWER: **EDTA** [accept **ethylene·diamine·tetra·acetic acid** or **ethylene·diamine·tetra·acetate** or **ethylene·diamine-*N*,*N*,*N′*,*N′*-tetra·acetic acid** or **ethylene·diamine-*N*,*N*,*N′*,*N′*-tetra·acetate**]

10. **Kaneda created a family of dyes by appending a phenol motif to one of these compounds using an azo linker. One comma one-prime binaphthyl motifs were incorporated in the first chiral examples of these compounds prepared by Donald Cram. The combination of one of these compounds and KHMDS improve the *Z*-selectivity of a reaction between phosphonates and aldehydes named for Still and Gennari. Some atoms of these compounds are replaced by nitrogen in BiBLEs(*)**. "Purple benzene" can be prepared dissolving potassium permanganate in benzene using one of these compounds as a phase-transfer catalyst. The names of these compounds contain two numbers, the second of which denotes the number of oxygen atoms within their cavity. For 10 points, name these cyclic compounds which contain carbon-oxygen-carbon motifs.
ANSWER: **crown ether**s [prompt on "**ethers**"]

11. **In a paradox formulated by Bacry, the frequency of this effect vanishes in one inertial reference frame, but is nonzero in another inertial frame orthogonal to the first one. Under Fermi–Walker transport, polarization vectors experience this effect. The value of one component of the Pauli–Lubanski pseudovector changes continuously as a result of this effect. This effects formulator used it to explain the fact that a *g*-factor of 2 could explain the anomalous Zeeman effect but would give only half the splitting size. The angular velocity of this effect is given by one over (*)** *c* squared times the quantity gamma squared over gamma plus one, times *a* cross *v*. Two successive Lorentz boosts in an accelerated frame cause a Wigner rotation, which leads to this effect. For 10 points, name this relativistic correction to the spin of a particle travelling in a curvilinear trajectory, named for a British physicist.
ANSWER: **Thomas precession**

12. **J. P. Grime argued that this quantity has a unimodal relationship with productivity. Joseph Connell hypothesized that this quantity is maximized at intermediate levels of disturbance. Effective evolutionary time is one hypothesis that attempts to explain the latitudinal gradient of this property. This quantity has a power-law relationship with (*)** area. Robert Whittaker described three forms of this quantity across different spatial scales called alpha, beta, and gamma. Evenness and richness are incorporated into the Shannon–Wiener index of this property. This property can also be calculated using the Simpson index, which measures the probability that two organisms samples from a community will belong to different species. For 10 points, name this property that represents the number of different species in a community.
ANSWER: species **diversity** [accept bio**diversity**; accept species **richness** until "richness"]

13. **An opponent to this theory argued that his vest didn't need to be loosened because he wasn't a paid shill. A defender of this theory compared himself to Malcolm X in a room full of police. A man promoting this theory encourages people to "do your research" on Holocaust denier David Irving. That defender of this idea claimed he wasn't doing "anything stronger than weed" in reply to the accusation that clouds were "messing with his brain." That supporter of this theory also tweeted "that awkward moment when you realize you've been indoctrinated into a (*)** heliocentric belief system," and he penned the line "Globalists see me as a threat." For 10 points, name this "five centuries regressed" idea that Neil deGrasse Tyson's nephew argued against in the lyric "B-O-B has gotta know the planet is a sphere G."
ANSWER: the **Earth** is **flat**

14. **An experiment at the Jefferson Laboratory measures neutron density and this quantity using Z-zero bosons that couple with neutrons. A "knife-edge" approach to calculating this quantity can rely on lunar occultation or eclipsing binaries, but the latter has the advantage of being free of diffraction artifacts. A direct measurement of this quantity through a telescope produces an (*)** Airy disk, which means one has to multiply the answer by 1.22 to correct for diffraction effects. Luminosity is proportional to this quantity squared, and the milliarcsecond is the most common unit to measure it for distant objects. A version of this quantity equals 2 *MG* over *c* squared, and it gives the distance at which escape velocity equals the speed of light around a black hole. For 10 points, name this quantity, one of which is named after Schwarzschild.
ANSWER: **radius** [or **diameter**; or angular **radius**; or angular **diameter**; or Schwarzschild **radius**; prompt on "**size**" or vague answers; do not accept "distance"]

15. **Körner added this functional group to compounds to determine which isomer they were in his "absolute method." Chiral lanthanide binaphtholate catalysts named for Shibasaki were first employed in an aldol variant involving this functional group. The Henry reaction's alternate name refers to this functional group. Picric acid comprises three of these functional groups bound to phenol. These functional groups are found ortho to carboxylic acids in a reagent for quantifying thiol concentration named for (*)** Ellman. Silica gel impregnated with sodium methoxide converts this functional group to a carbonyl group in the Nef reaction. Zinc and hydrochloric acid reduce this meta-directing functional group to an amine. For 10 points, name this electron-withdrawing functional group, three of which are bound to toluene in the explosive TNT.
ANSWER: **nitro** group/compound [or **NO2**]

16. **The CYCLOIDEA gene has been implicated in transitions from actinomorphic to zygomorphic symmetry in these structures. A quartet of MADS domain transcription factors is thought to be involved in the development of these structures, which is affected by genes like FLC and CONSTANS. When these structures are arranged in an umbel, (*)** pedicels originate from a common point. Herkogamy and dichogamy can be exhibited by monoecious forms of these structures. One model posits that class A, B, and C genes affect the development of different parts of these structures. Complete types of these entities contain a perianth, gynoecium, and androecium. These structures may produce color and nectaries to attract pollinators. For 10 points, name these structures unique to angiosperms which contain the sepals, stamens, carpels, and petals.
ANSWER: **flower**s

17. **Tosyl chloride and a base are used to convert betaxamic acids to these compounds in the Lossen rearrangement. Biurets, not to be confused with burettes used in titrations, are most commonly formed from the trimerization of this functional group. They are commonly produced by reacting amines with phosgene. In one reaction, work-up of one of these compounds with an alcohol or amine yields a carbamate or urea derivative, respectively; that reaction involves the thermal decomposition of an (*)** acyl azide in which nitrogen gas is released. $Br_2$ and NaOH can be used to convert amides to amines through an intermediate with this functional group. This functional group is hydrolyzed in the last step of the Hofmann rearrangement, and they can be synthesized by the Curtius rearrangement. A thio- derivative of them is used in the Edman degradation. For 10 points, name this functional group containing a carbon double bonded to both a nitrogen and an oxygen.
ANSWER: **isocyanate**

18. **These spaces are connected to their dual spaces by the Riesz representation theorem. By Alaoglu's theorem, every bounded sequence in one of these spaces admits a weakly convergent subsequence. Equipping one of these spaces with a Gelfand triple creates a "rigged" one of these spaces, and one of these spaces is separable if and only if it admits a countable orthonormal basis. A (*)** Sobolev space is one of these spaces in which differentiation may be performed. All of these spaces are also Banach spaces, where the inner product is also the norm. These spaces include the space of all square-integrable functions, including *L*-2. Observables in quantum mechanics are represented by operators in these spaces. For 10 points, identify these spaces, which are named for a German mathematician.
ANSWER: **Hilbert space**

19. **The endogenous retrovirus HERVH is expressed specifically in these cells and act as a scaffold for the recruitment of chromatin remodelers and transcription factors. In these cells, the long intergenic non-coding RNA ROR takes up microRNAs that suppress specific transition factors. Common media for the growth of these cells are 2i+LIF and KSR. In this type of cell in mice**, **(*)** Lin28 blocks the production of let-7. These cells can be generated through the addition of Oct4, Sox2, c-myc, and KLF4, transcription factors named for Yamanaka. For human cells of this type, the "gold standard" functional assay is teratoma formation. These cells that come from the inner cell mass from a blastocyst can differentiate into a cell from any of the three germ layers. For 10 points, name these undifferentiated cells that are normally found in early stages of human development.
ANSWER: induced **pluripotent stem cell**s [or **embryonic stem cell**s or **ESC**s or i**PSC**s; prompt on "**stem cell**"]

20. **Bella the frog hops out of a window left open by this person. This person accidentally recycles a toy soldier, causing it to be reduced to plastic pellets. This youngest member of the GRANITE organization turns orange after eating Sea Wheedies. When a colleague of this character says "I don't think (*)** dinosaurs are that terrible," this character replies "then how come the word dinosaur means terrible lizard?" This character is accidentally shown travelling inside his own digestive system in an episode where children scuba dive inside his stomach. This owner of the Field Trip Survival guide gets a cold after freezing solid on Pluto. For 10 points, name this Jewish, bespectacled, orange-haired student who often wishes he "stayed home" instead of joining field trips led by Ms. Frizzle on the Magic School Bus.
ANSWER: **Arnold** Matthew **Perlstein** [accept either underlined part]

21. **Sauvage used an ion of this element to hold 1,10-phenanthroline motifs in place in the first templated catenane synthesis. An isotope of this element forms a semithiocarbazone complex which is used as a source of beta particles in a common radiotherapy treatment. A series of enzymes which use this element to perform one-electron oxidations on monolignols for lignin synthesis are laccases. This element is usually bound in (*)** ceruloplasmin when transported in the blood. An atom of this element is bound to three histidine residues opposite an iron porphyrin in cytochrome C oxidase. A beta-barrel motif imposes a rigid coordination sphere on this element in plastocyanin. An alkaline solution of Rochelle salts is added to this compounds sulfate in a test for reducing sugars named for Fehling. Oxygen is bound between two atoms of this element in haemocyanin, the protein which gives spider blood its blue colour. For 10 points, name this element which is alloyed with zinc in brass and with tin in bronze.
ANSWER: **copper** [or **Cu**]

22. **One of these values was sold by William Tozier on eBay in 2004 for $1031 in an auction titled "Decrease your [this value]." Michael J. Barr has suggested a fractional form of this quantity. One type of this value with a stricter condition is known as this value "of the second kind." Jerry Grossman of Oakland University maintains a database of these quantities. Unlike the (*)** h-index, which measures impact, this quantity captures structural properties of a certain graph. This quantity is one in around 509 cases, and it is finite in approximately 300,000 cases. A quantity related to this value is also named for actor Kevin Bacon. The median of this value for Fields Medalists is three. For 10 points, name this value, a measure of the collaborative distance or "hops" between a person and and a prolific Hungarian mathematician.
ANSWER: **Erdős number**

23. **Using the Altarelli–Parisi evolution equations, Braaten, Cheung, and Yuan modeled the decay of the Z boson into one of these particles. When this particle is considered light, the chiral symmetry group is taken to be SU(3) cross SU(3). A puzzle about why a pair of diagrams with two internal W bosons were so small by led to the prediction that this particle must come in as a UV cutoff; that explains the suppression of flavor changing neutral currents. The D meson is the lightest meson to contain one of these particles, and its decay violates the conservation of this particle's namesake quantum number. Hadronic decay modes of a particle which contains this particle are suppressed by the (*)** OZI Rule. This particle's existence was hypothesized by the GIM mechanism. This particle is the third most massive of all quarks, after the top and bottom. For 10 points, name this quark, which along with its antiparticle forms the J/psi meson.
ANSWER: **charm** quark

24. **Radio emissions in this body's auroral region will be searched by the Polar Magnetosphere Suite's WAVES experiment. It's not Titan, but a probe that crashed into this body showed that its atmosphere's zonal wind speeds increased with pressure and depth, a discovery made by the Doppler Wind Experiment. That same probe used its solid state imager and near-IR mapping spectrometer to detect areas in this body's atmosphere that are free of water and ammonium hydrosulfide particles, known as its (*)** "hotspots." A spacecraft that orbited this body found that its largest satellite produced its own magnetosphere. *New Horizons* used this body for a gravity assist in 2007, *JUICE* is reaching it in 2030, and *Juno* is about to reach it in July 2016. Comet Shoemaker–Levy 9 collided with this body in 1994. The Galilean moons orbit this body. For 10 points, name this gas giant that houses the Great Red Spot.
ANSWER: **Jupiter**