1. **The Mills–Nixon effect in aromatic systems is based on this phenomenon. This effect equals the [difference in calculated and experimental enthalpies of formation], in Benson group increment theory. The sum of all terms in a molecular mechanics force field is this energy, which can be modelled by A values. In the "activation-THIS" or distortion/interaction model, the bite-angle effect is caused by this phenomenon. It is estimated by the Taft parameter E-sub-s. The (*)** g+g- pentane interaction causes the syn-pentane type of this effect. The Dunitz–Shomaker, or C1,3, type of this effect differs from its allylic A1,2 or A1,3 types. In triptycenes, this causes "gearing" in correlated rotation. Its electrostatic form is induced by oxyanion holes. This effect's Baeyer type works at varying angles. Cyclobutane's butterfly motion relieves its transannular type. Cyclohexane's chair has none of the ring type of this effect. For 10 points, name this effect with torsional and steric forms.
ANSWER: **strain** [accept specific types of **strain**, like angular, torsional, steric, or any named strain before read]

2. **The stress-energy tensor equals the derivative of this quantity with respect to a field times that field, all minus this quantity times a Kronecker delta. When this quantity is independent of a quantity, it may be useful to replace that quantity and its derivatives with the momentum; that is Routh's procedure. For a free particle, the relativistic form of this quantity is negative *mc* squared over gamma. One form of this quantity equals the (*)** Ricci scalar times the determinant of the metric. Adding a term to this quantity which is a total derivative importantly does not affect dynamics. Canonical momenta of a system are equal to the derivative of this quantity with respect to the coordinates. The time derivative of the partial derivative of this quantity with respect to *q*-dot equals the partial derivative of this quantity with respect to *q* in an equation whose solutions give the equations of motion. For 10 points, name this quantity that equals kinetic minus potential energy.
ANSWER: **Lagrangian**

3. **Matrigel and Boyden Chamber assays are used to study this process. Intravital videomicroscopy was developed to observe this process. A non-orthotropic, non-spontaneous technique inducing this process starts with lateral tail vein injections. The TIC hypothesis is of the initiation of this process, which the scratch wound assay confirms. One part of this process can be collective or [protease-, stress-fiber-, and integrin-independent], the latter of which is [Rho/ROCK-dependent (*)** amoeboid]. Poor-prognosis genes give the probability of this process, which also names initiation, progression, and virulence genes. Clonal selection, chemoattraction, and self-seeding are theories of this process, which Paget proposed the "seed to soil" hypothesis for. Intravasation and extravasation are stages of this angiogenic process, which includes the epithelial-to-mesenchymal transition. For 10 points, name this process, the spread of cancers to non-primary tumor areas.
ANSWER: **metastasis** [prompt on "**tumor growth**" by asking "What stage of tumor growth?"; prompt on "**invasion**", "**colonization**", "**intravasation**", "**angiogenesis**", or "**extravasation**" by asking "What broader process is _answer_ part of?"]

4. **Transfer occurs roughly equally in both directions in the M-component mechanism for this phenomenon. The value of one property of this phenomenon was inferred by residual magnetization in basalt located near the event. The puzzle of the abundance of "odd nitrogen" led Noxon to the demonstration that this phenomenon is an important abiotic source of nitrogen fixation. This phenomenon's dart leader propagates at about 10 million meters per second. One of these events begins with a stepped leader extruding from the base. This causes (*)** streamers to emerge from surrounding objects until one strikes the leader. Lichtenberg figures on the skin of those affected by it, and this phenomenon may be accompanied by expanding disks called Elves or diffuse flashes called sprites. For 10 points, name this phenomenon which can cause hollow quartz tubes called fulgurites when it hits sand and which is often followed by the smell of ozone.
ANSWER: **lightning** strikes

5. **In one analytical model of these processes, Padé approximants are used to determine the radiation reaction force in order to improve the PN-expansion. Suitable resummation methods are then used to obtain an accurate approximation of the entire waveform. Simulations of these processes were greatly improved in 2005 when physicists finally got their coordinates to stop collapsing. Analysis of this process is simplified by the effective one-body formalism, and the ringdown phase occurs at its end. The gravitational slingshot of a nearby star can speed up the timing of this process by decreasing the distance between the involved bodies; that mechanism can be used to deal with the (*)** final parsec problem. This process led to the production of GW 150914, which was LIGO's first-ever detection of a gravitational wave. For 10 points, name this process in which two massive distortions of spacetime join into one similar, bigger, object that doesn't let light escape.
ANSWER: binary **black hole merger** [accept logical equivalents like "black hole collisions"; prompt on partial answers like "**binary mergers**"]

6. **This compound is added to solutions of citrate-complexed metal ions in the Pechini process for sol-gel synthesis of homogeneous mixed metal oxides. This compound and its oligomers are often used to dehydrate natural gas. A carbonyl is refluxed in this compound along with a strong base and hydrazine hydrate in a common improvement of the (*)** Wolff–Kishner reduction. One process for producing this compound reacts carbon dioxide with oxirane in the first step to produce a carbonate, which is then hydrolysed to give this compound. 1,3-dioxolanes are produced by the reaction of this compound with carbonyl groups in a common strategy for their protection. Patients who have ingested this compound are often treated with ethanol. For 10 points, name this common antifreeze, a two-carbon diol.
ANSWER: **ethylene glycol** [accept **ethane-1,2-diol** or **1,2-dihydroxyethane**]

7. **This scientist argued that the mind constructs reality through a series of "unconscious inferences" in his sign theory of perception, which extended the work of his teacher Johannes Müller. The magnetic field at the center of a device named for this scientist has a factor of four-fifths to the three-halves. This scientist names the statement that functions in 3D can be broken into a gradient piece and a curl piece. Another statement due to him is that the flux of (*)** vorticity across a vortex tube is constant. Very uniform magnetic fields may be made with a device named for him in which two solenoids are placed next to each other at a distance equal to their radius; that is his coil. His equation says that the Laplacian plus *k* squared acting on a function equals zero. He extended Young's theory of trichromatic color vision. For 10 points, name this scientist whose free energy equals internal energy minus temperature times entropy and is defined at constant volume, in contrast to that of Gibbs.
ANSWER: Hermann von **Helmholtz**

8. **The shallowest form of this process occurs when limonite is dehydrated to hematite leaving behind red beds. The two main forms of this process with respect to quartz are secondary overgrowths and pressure solution. Chert forms as a result of some type of this process. This process can be split into three stages prefixed by eo, meso, and telo. An important example of this process in which increased pressure and depth lead to a decrease in porosity is known as compaction. This process generally occurs early after the formation of limestone via a mix of meteoric and marine water causing (*)** dissolution and recrystallization. This process is similar to metamorphosis, but occurs at lower temperatures and pressures. For 10 points, name this process in which a sedimentary rock undergoes physical, chemical, or biological changes following its deposition.
ANSWER: **diagenesis**

9. **The last two bytes of a sector named for this process are the magic number 0xAA55. The first block of every partition is always a block named for this process and is followed by a superblock. At the end of this process, one is dropped into a specific runlevel, which is now-a-days managed by systemd. A few years back, this process was mediated by the program GRUB, which ended with the unpacking of init-ram-fs and execution of forward-slash init. The most modern forms of this process start by initializing (*)** EFI firmware; less modern forms use sector zero on a hard disk, which contains the MBR, to initiate this process. The first step in this process is starting the BIOS, which first initiates a POST, or power-on self-test. For 10 points, identify this process in which a computer's operating system starts up.
ANSWER: **boot**ing in Linux [or **boot**strapping; or **boot** sequence; or Linux **startup** process until "starts up" is read]

10. **In order to find out whether a member of this profession really loves him, Philip Engstrand enters an entity named Lack, which had previously swallowed a cat named B-84, in *As She Climbed Across the Table* by Jonathan Lethem. In a different play, one of these people tells another, "Germany is where I was born. Germany is where I became what I am. Germany is all the faces of my childhood, all the hands that picked me up when I fell…." A book named after one of these people contains the story "The Little Puppy That Could" and begins with a long essay called (*)** "Thinkability." Two of these people, who enjoy skiing and table tennis, respectively, say "Another draft" when they decide that they have wrongly interpreted a past event. Martin Amis wrote a book about named after the "monsters" of one member of this profession. In a play, Margrethe and the spirits of two of these people discuss a 1941 meeting. For 10 points, name these people who are the subject of Michael Frayn's *Copenhagen*.
ANSWER: **physicists** [prompt on "**scientists**," obviously] <WN>

11. **This technique can be used to study the dynamics of indirect excitons by measuring their photoinduced reflectivity and Kerr rotation. An optical delay line is an essential element to the set-up used in this technique. Some of the first uses of this technique were to observe the disintegration of cyanogen iodide and dissociation of sodium iodine. This technique can be used to study energy relaxation processes and is improved upon by four-wave mixing. Results of this technique are often plotted on a graph of (*)** pulse time delay versus absorption spectra. In this technique, one laser beam optically excites a species and then another one follows quickly behind to take a snapshot of the excited state; the time between those two pulses is then varied to gain a complete picture of the chemical process at a short time scale. The 1999 Nobel Prize in Chemistry went to Ahmed Zewail for his use of this technique in a new branch of chemistry. For 10 points, name this alliterative type of spectroscopy fundamental to femtochemistry.
ANSWER: **pump-probe** spectroscopy [prompt on "**femtochemistry**"; prompt on "**ultrafast**" laser spectroscopy; accept "**transient-absorption**" spec]

12. **Abramov showed that for a measurable flow on a Lebesgue space, this quantity increases at time *t* is equal to *t* times this quantity at time 1. A form of this quantity for a dynamical system may be computed as the limit as epsilon goes to zero of the limit as *n* goes to infinity of the supremum of one over *n* times the log the of number of epsilon-separated sets. That topological form of this quantity is the log of the number of piecewise-monotonic sections, and is the supremum of the measure-theoretic type, which counts the number of minimal subcovers. For a discrete variable, this quantity is equal to negative one times the sum of the probability mass function at each value times the (*)** log of the mass function at that value. For 10 points, name this word for quantities described by Kolmogorov and Shannon, which is analogous to a physical quantity describing disorder.
ANSWER: **entropy**

13. **Four measurements of intensity from these devices are needed for the ABCD method for determining the modulus and phase of a function classifying them. Some results of this technique are dirty beams/maps that are fed into a program named CLEAN. One method of using the Earth's motion to change the orientation between these devices and the source is called Earth rotation synthesis. A technique that removes spatial frequencies to clean the output of these devices is called (*)** spatial filtering. Whether or not their inputs have the same frequency is the basis of their classification into homodyne and heterodyne detection. One source of noise in these devices that may be used to measure surface roughness is speckle. One type of these devices that splits the light into two paths and recombines them after reflection was used by its inventor to test the ether drag theory and measure the speed of light; that is the Fizeau type. For 10 points, name these devices that measure phase shifts in light based on visible light fringes.
ANSWER: **interferometer**s

14. **The woman best known for developing this program also cloned her own brain to create an artificial intelligence whose first words were Italian for "When the game is over, the king and the pawn go in the same box." The false diagnosis of Boren's syndrome was originally used to cover up an immunity conferred to one character by this program. The Sangheili race almost exclusively refer to the products of this program as "demons." After its deactivation, the ORION project was retroactively dubbed the first version of this program, which was directed by Catherine Halsey. One of these character who (*)** resulted from this program is told "but you had something they didn't. Something no one saw, but me. Can you guess…? Luck." This group's most famous character is introduced by being thawed out on the Pillar of Autumn where'd he'd apparently been cryogenically frozen while still where his MJOLNIR Mark V armor, and asks Admiral Hood for permission to leave the ship "to give the Covenant back their bomb." For 10 points, name these super soldiers from the Halo universe who include Master Chief.
ANSWER: **SPARTAN** [accept **SPARTAN II**; prompt on "**ORION**" until read]

15. **Furshpan and Potter discovered rectifying synapses that are between these cells. The C-start is caused by Mauthner neurons synapsing onto these cells and cross-inhibitory cells. Command neurons, which map to behaviors one-to-one, are also this type of neuron. The "gamma loop" includes gamma and alpha types of these neurons. The spinal cord's (*)** ventral roots contain their axons. Electroplaques emitting 'hunting doublets' cause supramaximal activity in these neurons. The lateral and medial giants in crayfish tails are these neurons. Hodgkin and Huxley studied giant axons of these neurons in squids. During the asynchronous recruitment of their namesake units, tetani can result from the continuous firing of these neurons, which floods T-tubules with calcium. For 10 points, name these final neurons in reflex arcs that release acetylcholine onto neuromuscular junctions.
ANSWER: **motor neuron**s [accept **motor**, **lateral**, or **medial giants** until read, both parts required; prompt on "**neurons**"]

16. **Smythe extended a certain scalar theory of this phenomenon to express a quantity as the curl of the integral of the normal cross the E-field times *e* to the *IKR* over *R*. For a system complementary to an original, this process can be described by setting the E-field equal to *c* times the original B-field, and setting the B-field equal negative one over *c* times the original E-field. In one regime the intensity of this process is proportional to the square of the sinc function of a constant times the sine of the angle. Analysis of this process often relies on the (*)** principle that every point on a wavefront acts a source of spherical waves. This process imposes a limit on the resolution of an aperture equal to 1.22 times wavelength over aperture size. When the distance is much farther than the slit width, the far field, or Fraunhofer limit is applicable. For 10 points, name this process by which waves bend around obstacles in their path.
ANSWER: **diffraction** [accept word forms; prompt on "**scattering**" or "**interference**"]

17. **In one appearance, this character has a headache and is stumped by a puzzle asking for a word containing the consecutive letters "A-D-A-C." In another appearance, this person takes a notebook out of his helmet because pockets don't exist yet. A Genie, Meta-Genie, Meta-Meta-Genie, and so on grant this man a Typeless Wish, so he wishes "I wish my wish would not be granted!," causing him to be sent to Tumbolia. This character tries to convince another character that if he (*)** accepts A, B, and C, then he must accept Z, but this leads to an infinite regression. In Douglas Hofstadter's *Gödel, Escher, Bach*, this man participates in dialogues with friends like Anteater, Sloth, and Crab. Lewis Carroll wrote a story titled "What the Tortoise Said to" this person. For 10 points, name this footracer in one of Zeno's paradoxes.
ANSWER: **Achilles**

18. **According to internet physicist extraordinaire Ron Maimon, this man rose to prominence because he was the only physicist on the East Coast "who actually could read." After 't Hooft ("uht-HOAFT") showed viability of a QCD expansion in the number of colors, this man elucidated that theory for baryons. This man introduced a Schwarz-type topological quantum field theory in 2-plus-1 dimensions that has expectation values equal to the Jones polynomial; that is Chern–Simons theory. For a Riemannian four-manifold with a spin-C structure, massless magnetic monopoles correspond to solutions to a set of equations named for Seiberg and this man. His best known contribution is the realization of T-duality among several different (*)** 10-dimensional theories, leading to his 11-dimensional theory. For 10 points, name this king of theoretical physics who won the Fields medal for unifying disparate branches of string theory into M-theory.
ANSWER: Ed **Witten**

19. **Rejected transplants of this area's tissue show the "RSVP" signs. Map-dot-fingerprint or Cogan's dystrophy occurs when this structure's basement membrane is malformed. Granit's components are waves from this structure. In keratoconus, one of this structure's layers degenerates, bending it outwards. This structure is enriched in fibril-associated collagens with interrupted triple helices. (*)** ERG electrodes are placed on it. In Wilson's disease, Kayser–Fleischer rings form in this structure. The "reshaping" of this area using an excimer laser is LASIK's first step, and can correct this structure's changed curvature in astigmatism. Air puffs to this structure measure intraocular pressure. Scleral lenses bypass this structure, which the conjunctiva does not cover. For 10 points, name this transparent, frontmost layer of the eye.
ANSWER: **cornea**

20. **This character tells his future wife, in Portuguese, "thou art fertile ground, and I will plant a tree in thee." His brother tells him "the power to cause pain is the only power that matters… because if you can't kill then you are always subject to those who can." Later in his life, this character travels to the descolada virus-infested Lusitania where he mediates a conflict between humans and pequeninos. While playing a game in which he is presented two cups of poison by a giant, he chooses to gouge the giant's eyes out instead. After committing (*)** xenocide against the formics, he becomes a pariah and adopts the title "Speaker for the Dead." He was conceived to be half as empathetic as his sister and half as ruthless as his brother, who adopt the pseudonyms Locke and Demosthenes to publish political tracts. His "jeesh" includes Hot Soup, Petra, and Bean. For 10 points, name this protagonist of a series of Orson Scott Card books, including one about his "game."
ANSWER: Andrew **Ender** Wiggin

21. **This is the heaviest element in a co-catalyst which is often added super·stoichiometrically to Kaminsky catalyst systems for olefin polymerisation. A common precursor for atomic layer deposition of this element's oxide is a bow-tie shaped organometallic compound. The beta polymorph of this element's oxide serves as a host framework for fast sodium ion conduction in BASE. This element's (*)** isopropoxide catalyses the Meerwein–Ponndorf–Verley reduction. That bow-tie organometallic compound containing this element reacts with titanocene dichloride to prepare Tebbe's reagent, and it can be partially hydrolysed to give MAO. This element is found with silicon and oxygen in zeolites. A lithium counterion stabilises a powerfully reducing anion which contains this element bound to four hydrides. The Bayer process often precedes a process where this element's oxide is dissolved in cryolite before undergoing electrolysis. For 10 points name this element whose principal ore is bauxite.
ANSWER: **aluminium** [or **Al**; accept **aluminum** from Americans <3 ewan]

22. **In his PhD thesis, this computer scientist extended context-free grammars by attaching stacks of indices to the non-terminals, creating indexed grammars. This computer scientist is the alphabetically first namesake of an algorithm that refines a keyword trie ("try") to implement exact set matching. That algorithm is used by the regex-less fgrep for string matching and is named for this computer scientist and Margaret Corasick. This computer scientist is the alphabetically first author of two extremely influential textbooks: *Design and* (*)** *Analysis of Computer Algorithms*, as well as all the editions of *Principles of Compiler Design*, the *Dragon Book*. Nearly all of his most influential books were co-authored with Jeffrey Ullman. For 10 points, identify this first namesake of the AWK programming language, which is also named for Peter J. Weinberger and Brian Kernighan.
ANSWER: Al **Aho** [or Alfred Vaino **Aho**]

23. **In a weak sense, quantum computers can compute this function in logarithmic time, which is the basis of Shor's algorithm. The quadruple iterate of this function is multiplication by a scalar. Applying this function to a character on an abelian group yields a function on its Pontryagin dual which is supported at one point. This function is a linear automorphism of the Schwartz space *S* of R-*n*. This function is also a linear automorphism of *L*-2 of R-*n*, which follows from the theorem that this function is a unitary linear transformation; that theorem is (*)** Plancherel's theorem. The theorem that this function interchanges pointwise multiplication and convolution can be used to multiply polynomials quickly. For 10 points, name this linear operator that intertwines the position and momentum operators for the wavefunctions of a free particle.
ANSWER: **Fourier transform**

24. **Sergei Gavrilets imagined these constructs as "holey" and wrote about their application to the origin of the species. Selection weighted attraction graphing, or SWAG, uses force-directed network graphing to visualize them. Catalytically perfect, or diffusion-limited, enzymes represent absolute maxima on these constructs. They're similar to John Maynard Smith's idea of sequence spaces, but with an associated parameter for each possible sequence. Stuart Kauffman's NK model is based on a (*)** "tunably rugged" one. Directed evolution experiments are analogous to climbing hills on then. These constructs' formulator used them to describe his shifting balance theory of evolution. Developed by Sewall Wright, for 10 points, name these constructs used to map out the relationship between genotype and reproductive success.
ANSWER: **fitness landscape**s [prompt on partial answer]