1. **Matthias Gunther gave a proof of this theorem using a bilinear smoothing operator to avoid the iteration scheme on which the proof of it originally relied. The namesake of this theorem proved it using a namesake generalization of the inverse function theorem that allows one to show the existence of a unique solution to partial differential equations. Its namesake proved it using Newton's method with post-conditioning, and this theorem allows for the preservation of distance when transitioning into Euclidean space. For 10 points, name this theorem that allows one to put Riemannian manifolds into Euclidean space, named for an American mathematician whose work in (*)** game theory led to his namesake equilibria.
ANSWER: **Nash embedding** theorem [prompt on partial]

2. **2M1207 was the first of these objects determined to have a planet orbiting it. WISE has detected a number of these objects falling within the *Y* class, and the Gaia spacecraft is expected to some of them falling within the *L* class. Discovery of Teide 1 confirmed the existence of these objects, and (*)** Gliese 229B is the prototype example of the *T* class of these objects. One theory posits that either one of these stars or one of their red counterparts are responsible for mass extinctions by sending comets from the Oort cloud towards Earth. The lithium test can be used to identity these stars. For 10 points, name these "failed stars" that aren't heavy or hot enough to fuse hydrogen in their core.
ANSWER: **brown dwarf**s

3. **In one of these devices, in order to achieve resonant frequencies greater than 2 kHz, microfabrication is used to minimize mass of one component to less than one nanogram, thereby optimizing the *k* to *m* ratio. That instrument was an improvement on another one of these things which was incompatible with non-conductive samples. Smearing in one of these devices is calculated by the square root of quantity radius of curvature times tunnel distance, and in that instrument, work function induced structures are separated from true structures by modulating the distance between the (*)** tip and the sample. For 10 points, give this instrument that comes in "atomic force" and "scanning tunnelling" varieties, and is used to look at things that are too small for the naked eye.
ANSWER: **microscope** [accept **atomic force microscope** or **scanning tunnelling microscope**; accept **microscopy** in place of "microscope" in any of those answers; do not accept other specific types of microscopes]

4. **The dressing function for these particles has infrared power behavior. The most common way to make the Higgs Boson at the LHC involves two of these particles combining to form a virtual quark loop. Lines representing these particles form tube-like structures in the Lund string model. The spin of these particles was determined by studying the Ellis-Karliner angle of positron-electron collisions. The first direct evidence for the existence of these particles was found by studying (*)** three-jet events. The force these particles mediate is described by SU(3) symmetry, and these particles come in 8 different types. These particles carry the color charge. For 10 points, name these particles that hold quarks together by mediating the strong force.
ANSWER: **gluon**s

5. **Failure of these cells to properly redistribute potassium ions may be linked to temporal lobe epilepsy. The ganglioside GD3 can be used to trace the development of one type of these cells from its progenitor cells; that type is identified by dense cytoplasm and clumped chromatin in its nucleus. A namesake (*)** fibrillary acid protein is used as marker to detect the "star-shaped" type of these cells. Cerebrospinal fluid is secreted from one type of these cells, while another type is responsible for secreting the myelin sheath. For 10 points, name these cells - exemplified by oligodendrocytes and astrocytes - that provide physical support and nutrition to neurons.
ANSWER: **glial** cells [accept **neuroglia**; accept **astrocytes** in the first line, anti-prompt eafter; anti-prompt "oligodendrocytes"; do not accept or prompt on "neurons"]

6. **Quantum relative entropy refers to the von Neumann type of this thing. Introducing fictitious mass terms allows one to deal with the presence of this thing arising in loop integrals in a technique named for Pauli and Villars. Renormalization can be used to deal with unwanted high energy objects in a problem named for ultraviolet and this word. In curved spacetimes, only the covariant type of this (*)** operation applied to the stress-energy tensor vanishes. Negative one times the partial time derivative of density equals this operation applied to the product of density and velocity. Charge density divided by the permittivity of free space is equal to this operation applied to the electric field. Applying this operation to the magnetic field returns zero. For 10 points, name this vector calculus operation symbolized del-dot.
ANSWER: **divergence**

7. **Near the end of the music video for this song, the lead singer finds boxes containing a pigeon specimen and a pair of sunglasses circa 2011. Fuzzy scenes of the wild are interspersed throughout the music video for this song, which opens with "Where in the World Can My Lover Be?" playing in the background. Its lead signer states "I wanna walk on your wavelength / and be there when you vibrate. For you I'll risk it all." That line is followed by the guest artist stating that (*)** he "knows a bar out in Mars." The chorus for this song consists of the lines "Kiss me, ki-ki-kiss me/ infect me with your love and / fill me with your poison." The singer calls her "futuristic lover" an alien, in for 10 points, what Katy Perry song featuring Kanye West?
ANSWER: "**E.T.**"

8. **Du *et al.* reported that enantioselective photochemical examples of these reactions can be catalyzed using a transition-metal photocatalyst and a stereocontrolling Lewis acid cocatalyst. Carbonyls react with alkenes in a photochemical example of these reactions named for Paternò and Büchi. Copper catalyzes a reaction of this type from click chemistry between an azide and an alkyne; that reaction is named for (*)** Huisgen. In the most famous of these reactions, a diene and a dienophile react together in a $4 + 2$ fashion. Two pi bonds are converted to two sigma bonds in these reactions that are exemplified by the Diels-Alder reaction. For 10 points, name this class of reactions in which two or more reactants join together in a ring.
ANSWER: **cycloaddition** reactions [prompt on "addition" or "cyclization" reactions]

9. **Miki's protein-carbohydrate model described this process among yeast cells with carbohydrate alpha-mannan receptors and protein zymolectins. In one mechanism for this phenomenon, a high-molecular-weight cationic polymer such as CPAM is added to induce the formation of certain particles which immediately reduce in size due to mechanical shearing. Although it's not Brownian motion or diffusion, the time-evolution of the number density of particles as they undergo this process is given by the (*)** Smoluchowski equation. This phenomenon occurs with zeta potentials of up to plus or minus 5. More or less synonymous with agglomeration and coagulation, for 10 points, give this type of colloid instability in which particles come out of suspension and form flocs.
ANSWER: **flocculation** [prompt on "coagulation" due to ambiguities]

10. **Attempts to increase this molecules efficiency include replacing its small subunit with an algal copy, as the latter promotes pyrenoid formation, which in turn activates the carbon-concentrating mechanism. The gene for this molecule's large-chain subunit is found in non-nuclear DNA. A namesake activase removes the inhibitory molecule CA1P from this enzyme's carbamylated active site. When atmospheric (*)** CO_2 levels are low, this enzyme catalyzes an unfavorable reaction with oxygen in a process known as photorespiration. 3-phosphoglycerate is the product of a reaction it catalyzes. For 10 points, name this enzyme which catalyzes the first step of the Calvin cycle and is the most abundant protein on Earth.
ANSWER: **RuBisCo** [accept **ribulose**-1,5-**bisphosphate carboxylase** oxygenase]

11. **Bernard Schutz and Clifford Will introduced a technique based on this method for finding complex normal mode frequencies of black holes. For three-dimensional problems with spherical symmetry, the Langer correction is applied to this method. If $E = V$ when using this method, one has to introduce Airy functions to find solutions. Although it fails at (*)** "turning points," this method can be used to derive exact solutions for tunneling probabilities. In this method, functions are expanded as power series of h-bar and the wavefunction is treated as an exponential function with slowly varying amplitude and phase. For 10 points, name this approximation that is named for three scientists and is used to solve the Schrodinger equation.

ANSWER: **WKB**J approximation [or **Wentzel-Kramers-Brillouin**-Jeffreys approximation; accept all those people or letters in any order; accept "method" in place of "approximation"; accept **L**iouville-**G**reen method; prompt on perturbation theory]

12. **Examples of these minerals that grow so close together that X-ray diffraction is required to distinguish them are termed cryptoperthites. Alternating layers cause a milky luster below the surface of gemstones in an effect named for its prevalence in an example of these minerals called (*)** adularia. Calcium containing examples of these minerals also have two atoms of both aluminum and silicon and are exemplified by labradorite and anorthite. The continuous branch of Bowen's reaction series has calcium rich types of these minerals at the top, followed by sodium rich ones below; that type of these minerals is plagioclase. The orthoclase type of these minerals has a hardness of 6 on Mohs scale. For 10 points, name this most abundant class of minerals within the earth's crust.

ANSWER: **feldspar**s

13. **The MLCS method is used to standardize these diagrams, and they can exhibit anomalies due to the Blazhko effect. The Kepler mission has used the BEER algorithm to analyze these diagrams in search for hot Jupiters. For type Ia supernovae, the maximum value on these diagrams is inversely proportional to the successive rate of decay. Primary and secondary (*)** eclipses in binary systems correspond to dips on these diagrams. These diagrams for Cepheid variables are often said to look like shark fins and exhibit periodicity. For 10 points, name these diagrams that depict the brightness of an astronomical object over a period of time

ANSWER: **light curve**s

14. **The sheaf of a function with this property is fine. Hartog's theorem requires each variable of a complex function to have this property. Functions with this property are often studied on one-dimensional complex manifolds called Riemann surfaces. By necessity, space-filling curves lack this property. (*)** A set of two partial differential equations is used to determine whether a complex function has this property; those equations are named for Cauchy and Riemann. A function f has this property at a point x if the limit as h goes to zero of f of x plus h minus f of x all divided by h exists. For 10 points, name this property, which a function has if you can take its derivative.

ANSWER: **differentiable** [accept **differentiability**, or **complex-differentiable**, or **holomorphic**]

15. **This quantity is represented by green lines on a Stüve diagram, and lines representing one form of this quantity are drawn at approximately right angles to isotherms on thermodynamic diagrams. The difference between two forms of this quantity causes foehn winds. The height of the lifting condensation level can be found as the difference between temperature and dew point divided by the difference between two versions of this quantity. This quantity is equal to the negative derivative of temperature with respect to (*)** altitude. Atmospheric stability can be determined by comparing the environmental and adiabatic forms of this quantity. For 10 points, name this quantity, which tells you how much colder the air gets as you go up.

ANSWER: **lapse rate** [accept specific types like adiabatic **lapse rate**, environmental **lapse rate**, etc.]

16. **Inflammatory polyps in these structures can cause anosmia. An increase in the number of specialized epithelial cells called goblet cells is correlated with decreased ciliary beating in them. These structures are divided into four subtypes known as sphenoidal, ethmoidal, frontal and maxillary. These structures are commonly affected by (*)** rhinovirus, and when mucus flow out of them is blocked their namesake infection results. For 10 points, name these air-filled sacs that surround the nasal cavity.
ANSWER: paranasal **sinus**es [prompt on "nose"]

17. **This scientist is the second namesake of a model that treats the Universe as a lattice of regular cells containing masses at their centers. He's also the second namesake of a process that describes the mechanism by which photons could be collided together to form matter. The Hamiltonian constraint acting on the wave function of the Universe and returning zero is a representation of an equation this scientist names with (*)** DeWitt. A series of variations on the double-slit experiment trying to determine the nature of what makes light go through the slit it does are called his "delayed choice" experiments. For 10 points, give this physicist who names an interpretation of quantum mechanics called absorber theory with his once student, Richard Feynman.
ANSWER: John Archibald **Wheeler**

18. **The Worley form of this phenomenon is used for simulating the texture of things like stones, water, and cells. The "simplex" version of this phenomenon is an improvement over its creator's earlier work, because it scales to higher dimensions and has lower computational complexity. That earlier form of this phenomenon is based on an algorithm whose steps are grid-definition, taking dot products, and interpolation. Both of those methods for creating this phenomenon were developed by (*)** Ken Perlin. A method of reducing this phenomenon using the normal distribution is called Gaussian smoothing. For 10 points, name this unwanted fluctuation in the brightness of digital images.
ANSWER: **noise**

19. **Studies of the formation of these things in Streptococcus mutans showed that the inability to produce CSP resulted in alteration of their architecture, while the inability to sense CSP resulted in reduced biomass. Cis-2-decenoic acid, a fatty-acid messenger, can induce the dispersion of these structures. The formation of these structures in Pseudomonas aeruginosa is caused by the las and rhl (*)** quorum-sensing systems. These structures are implicated in Legionnaire's disease and the ear infection otitis media. These aggregates are held together by the polysaccharide-rich "extracellular polymeric substance", which gives them a slimy texture. For 10 points, name these communities of bacteria that adhere to surfaces in moist environments, exemplified by dental plaque.
ANSWER: **biofilm**s

20. **These compounds are formed via the decomposition of a tosylhydrazone with a base, after the formation of a carbene or carbenium ion intermediate. A sodium amalgam conducts the elimination reaction that generates these compounds in a procedure whose first step involves the addition of a phenylsulfonyl carbanion to an aldehyde or ketone. These compounds are produced in a reduction reaction that uses (*)** Lindlar's catalyst. Schrock, Grubbs and Chauvin name a number of catalysts for the metathesis of these compounds. The E-Z notation is used for isomers of these compounds. The ratio of carbon to hydrogen in these hydrocarbons is 1 to 2. For 10 points, name these compounds with a carbon-carbon double bond, the simplest of which is ethene.
ANSWER: **alkene**s [accept **olefins**]

21. **The state describing this property is broken down into s and p components in order to have its change measured in ellipsometry. Double Fresnel rhombs can be used to alter this property. When this property is only being partially experienced, 4 by 4 matrices named for (*)** Mueller are used to act on the vectors describing it. However when this property is being fully experienced, the Jones calculus may be used on those vectors. I, Q, U, and V are the entries into those aforementioned vectors describing this property, and are known as the Stokes parameters. Cosine squared appears in Malus' law for this property, which can come in elliptical, circular, horizontal, and vertical varieties. For 10 points, name this property of light in which it oscillates in one direction.
ANSWER: **polarization**