Science Monstrosity III: The Gay Science
Round 6

Indiana University

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1   Indiana University Tossups, Round 6

1. Sweeny suggested tackling it by using sum from k equals one to ∞ of $\frac{n^k(-1)^{k-1}}{k!k}$ minus the integral from n to ∞ of $\frac{e^u}{u}$. Sondow showed that if the fractional part of a specific triple product is equal to the LCM of a hypergeometric integral, then it is a rational number. However, if it is expressible as a fraction $\frac{a}{b}$, then b has to be larger than 10^{200000}. For ten points, name this constant, the sum from n equals one to infinity of the nth harmonic number minus $\log n$.
   Answer: <u>Euler</u>-Mascheroni γ constant

2. Demonstrating this experiment in a thyratron with an atmosphere of xenon commonly reproduces a distortion of the atomic wave function to fit the external wave function, a phenomenon known as the Ramsauer-Townsend effect. The temperature of its namesake apparatus must be maintained below 180 degrees Celsius to avoid damage to its Keithley Electrometer. In its first run, the observation of a 4.9 volt current drop attributed to inelastic collisions between accelerated and atomic electrons led to the postulation of an excitation threshold after which the atoms of mercury vapor may absorb energy. For 10 points, name this 1914 experiment that led to the confirmation of the Bohr hypothesis as the means of energy quantization.
   Answer: <u>Franck-Hertz</u> Experiment

3. The solutions for the combined equations for this value for an oblate body and the line of nodes as a function of inclination give rise to the Cassini States in gravitational dynamics, while during Couette Flow, its viscous analogues one and two are given by positive or negative $4\pi hB$. In electrodynamics, it may be calculated as the cross product of the magnetic dipole with the external magnetic field, and in simple mechanics the Euler-Bernoulli equation gives its value for a thin elastic beam. For ten points, what is this measure of energy defined as the derivative of angular momentum with respect to time?
   Answer: <u>Torque</u>

4. Zappulla and Cech described its secondary structure as a "T," with a pseudoknot domain at the base of the "T" connected to the BoxH/ACA region that is seperated from the Cr4-CR5 domain by a hypervariable paired region. In yeast, its RNA template lies at the junction of the "T" and is used by TERT to add repeating nucleotides to lengthen the ends of chromosomes to ensure proper replication. For ten points, name this enzyme with reverse trancriptase activity, and uses that to lengthen telomeres.
   Answer: <u>Telomerase</u>

5. Babinet's principle states that this phenomenon for complementary intermediates is equal to no intermediates at all. The Rayleigh-Sommerfeld formula for it is slightly simpler than the Fresnel-Kirchhoff formula it superseded, but both have similar boundary conditions: the field is undisturbed in the open areas of the aperture and zero on the opaque regions of the aperture plane. In the limit of small Fresnel numbers, the Fraunhoffer type only depends on the aperture angle. For ten points, name give this general term for the propagation of light near obstacles.
   Answer: <u>Diffraction</u>

6. The columns in this structure that radiate outward from the striated conical masses are named the *pars radiata* or the *processes of Ferrein*. The medulla of it consists of eight to eighteen *Malphighian pyramids*, which contain excretory ducts that empty into a minor calyx. Its primary functional unit begins as a double walled, cup-shaped expansion enclosing a tuft of capillaries known as the glomerulus. This expansion, Bowman's capsule, becomes a tortuous, confoluted mass called nephrons. For ten points, name these organs that separates urea and other nitrogenous waste products from the blood.
   Answer: <u>Kidney</u>

7. Because of polyarthralgias and glomerulonephritis, a serious complication of it is ENL, characterized by fever and neuritis, for which thalidomide was approved as a treatment in 1998. Facial deformities include enlarged earlobes and loss of eyebrows and eyelashes caused by destruction of the septum and cartilage by mycobacteria; Fite's stain can find them. The less severe subtype, tuberculoid, is characterized by large anesthetic and hairless patches. The most serious complication is trauma sustained because lesions

in nerves cause loss of pain sensation in the extremities. For ten points, name this progressive, chronic infection sometimes called Hansen disease.

Answer: _Leprosy_ or _Elephantiasis Graecorum_

Accept "Hansen" disease before its mention

8. Fray *et al* at the Max Planck Institute for Quantum Optics showed that it held for rubidium-85 and rubidium-87 in 2004, the first precise atomic-level verification. Bessel, drawing on an earlier experiment using weights of "gold, silver, lead, glass, common salt, wood, water and wheat" enclosed in eleven foot, wooden boxes, used two pendulums of identical length to confirm it, just as Newton had done before. Dicke famously criticized Eötvös's verification of it, suspecting that thermal events had upset the torsion balances. The "strong" version requires that the gravitational constant really be a constant and precludes a fifth force, but most kids get exited enough seeing a feather and bowling ball fall in a vacuum. For ten points, name this principle that states that all objects fall with the same acceleration under the influence of gravity.

Answer: Weak _Equivalence_ Principle

9. John Wallis used it in his proof that $\frac{\pi}{4} = \int_0^1 \sqrt{(1-x^2)}dx$, albeit in the Montmort form. Newton, in tackling a similar indefinite integral, noticed that the numerators of the coefficients are its elements. Brahmegupta in 628 showed its connection to the expansion of $(a+b)^3$, and Chu Shih-chieh and Al-Karaji gave the general construction rule, which was expanded by Newton for fractional inputs. For ten points, give this theorem giving the coefficients of $(a+b)^n$, sometimes expressed in Pascal's triangle.

Answer: _Binomial_ theorem/expansion

accept "Pascal's triangle" before mention

10. At constant temperature and volume, it is given by $-RT$ times the partial derivative of the natural log of the canonical partition function with respect to the component frequency, and at constant temperature and pressure, the Gibbs-Duhem equation indicates its dependence of its changes on the components of a mixture. It is equivalent to Fermi energy at absolute zero, and for a Bose-Einstein condensate or a conservative system of phonons, its value is exactly zero. For ten points, name this measure from physical chemistry defined as the constant temperature and volume partial derivative of Helmholtz free energy with respect to the number of particles, symbolized μ.

Answer: _Chemical potential_

11. Milborrow and Robinson showed that because mevalonate is incorporated into its – like the structurally similar Xanthan – biosynthesis is not localized to leaves, at least in oranges and avocados. Artsaenko showed that when a tobacco mutant sequestered this hormone in the ER, the plant's leaves wilted, thus suggesting its involvement in regulating the control of stomata. Described independently by Cornforth, who investigated its role as a factor in Sycamore dormancy, and by Ohkuma, for ten points, name this plant hormone whose name comes from its role in cotton seedlings, in which it promotes abscission.

Answer: _Abscisic acid_ or _ABA_ or _Dormin_

or _(2Z,4E)-5-[(1S)-1-hydroxy-2,6,6-trimethyl-4-oxo-2-cyclohexen-1-yl]-3-methyl-2,4-pentadienoic acid_

12. This material's unique properties became apparent with Pockels' discovery of its large quadratic electroptic Kerr effect, while its twin Curie temperatures were first established by Valasek. Its two bimorphs, used as "benders" and "twisters" in ceramics, are important nonresonant transducers, though its best-known property depends on a softening of its clamped dielectric stiffness, and the discovery of its hysteretic polarization launched ferroelectrics. A component of Fehling's solution also used to silver mirrors, for ten points, name this potassium sodium tartrate compound usable in crystal microphones due to its piezoelectricity.

Answer: _Rochelle_ Salt or _Seignette's Salt_

13. Each packet contains a 14 byte header, 46 bytes of data, and four CRC bytes for a total of 512 bits. A *p-persistent* algorithm extended from the Aloha protocol, when packets collide the senders back off. The protocol relies on fixed packet size, networks with maximum paths less than 2500 meters, and unique, 48-bit host addresses referred to as "MAC addresses." Because everybody has access to the network at

once, it's a less elegant solution than IBM's token-ring network, but its simplicity and low-cost made it the de facto standard. For ten points, name this networking hardware protocol developed by Xerox PARC that now comes in "Fast" and "Gigabit" varieties.
Answer: <u>Ethernet</u> or <u>802.3</u>, prompt on "Aloha"

14. He extended the work of Rattner to create a logical system capable of expressing simple statements about grasshoppers and petri dishes. Better known for his inventions, his 77X42 existed only briefly inside a magnetic field before being consumed by a massive, nearby object. His first patent was the AT-5000, although it was not used for its intended purpose. A professor at the S-H-I-T, he spends much of his time in his home laboratory building gizmos such as hamburger earmuffs, Floyd, a sweeping robot, and the Gamble-Tron 2000, which predicted Cincinnati to win by 200 points. For ten points, identify this thesis advisor to Apu Nahasapeemapetilan.
Answer: John <u>Frink</u>
Note: 77X42 is the Venus de Gummy and the AT-5000 is the autodialer

15. Malhotra, Pramodh-Kumar, and Maheshwari gave an $O(n^3)$ algorithm for constructing one using Fibonacci heaps to keep track of which nodes to delete. Dinic's algorithm requires $O(mn^2)$ time and solves this problem in terms of level graphs constructed by a series of advances and retreats to find an augmenting path. Because it uses augmenting paths constructed in a breadth-first fashion, it is a refinement of the Edomnds-Karp algorithm, itself a specific instance of the Ford-Fulkerson method for solving this problem. For ten points, give this network problem whose solution is equivalent to finding the minimum cut on a weighted graph.
Answer: <u>Maximum flow</u>

16. They were the subject of the 1970 POLYGON project led by Leonid Brekhovskikh. Jacobsen's method computes their namesake coefficients from a temperature-salinity diagram. Their time averaged variation gives rise to the isopycnal form stress, and they may induce thermally driven cell overturning in subtropical gyres. The Almeria-Oran front is a result of their occurrence in the western Mediterranean, and they are responsible for the retroflection of the Agulhas Current. The nutrient balance of the Sargasso Sea depends upon the Gulf Stream's shedding of them as it flows past Bermuda. For ten points, name these oceanic vortices – analagous to those created on large conductors by a magnetic field – generated when current flow past stationary water induces a small, circular localized reverse flow.
Answer: <u>Eddy</u> currents
PROMPT on "subgyre," or equivalent vagueness

17. Rarely found on Earth in its pure form, it's mostly found in wulfenite and powellite. Similar to tungsten but with half the mass, half as much can be used to impart the same hardness to alloys. It can form di-, tri-, tetra-, penta-, or hexa-valent bonds, which gives it considerable catalytic properties. The US produces half of it, mostly at the Henderson Mine and Mill in Empire, Colorado, where it is separated from copper. For ten points, name this Group VIb metal named by Carl Wilhelm Scheele as "lead-like" with atomic number 42.
Answer: <u>Molybdenum</u>

18. Charles Gibson was the first to use them and mercury diaryls to create quaternary phosphonium salts by introducing other radicals. E.P. Kohler is credited with bringing the use of them to the US and described the Reformatsky reaction, which involves an intermediate organozinc compound. When carboxylic acid derivatives react with them, a tertiary alcohol is formed after protonolysis. For ten points, name these alkyl- or aryl- magnesium halides used in forming Carbon-Carbon bonds, named after the 1912 French winner of the chemistry Nobel.
Answer: <u>Grignard</u> reagent

19. Under the operation $AB \equiv \frac{AB+BA}{2}$, they form a Jordan algebra. They are closed under multiplication only if the multiplicands commute. Quantum observables must be this type of operator because their eigenvalues are always real, and if their entries are real, these matrices are symmetric. For ten points, name these type of self-adjoint matrix equal to complex conjugate of its transpose.
Answer: <u>Hermite</u> or <u>Hermitian</u> Matrix

20. The role of pore fluid pressure in the formation of these structures is given by a modification of Byerlee's Equation that adds parameters for cohesive strength and effective normal stress. Dahlstrom Kinematics gives the constancy of forces associated with them, and according to Anderson Theory, they form when the third principle stress is vertical. Commonly stacked into imbricate fans, erosion of strata associated with them produces klippen and fensters. They may form in diapiric intrusion during salt-doming or when restraining bends cause thickening on one side of a transverse fault. For ten points, what are these features characterized by upward motion of the hanging wall, the opposite of normal faults?
   Answer: <u>*Reverse*</u> *faults or* <u>*thrust*</u> *faults*

   PROMPT on "dip slip" faults

2   Indiana University Bonuses, Round 6

1. Raise your arm if you're sure how anti-perspirants work. Well, that's okay, because most scientists aren't sure either. Answer the following questions about anti-perspirants for the stated number of points.

   (a) Antiperspirants contain partially neutralized chloride salts of metal ions, typically of either zirconium, or much more commonly, this metal hypothesized to impact breast cancer and Alzheimer's.
   Answer: **Aluminum**

   (b) One of the proposed mechanisms is that these glands, which produce perspiration without releasing cytoplasm, absorb the ions in addition to water, causing the pores to close, thus blocking the opening.
   Answer: **Eccrine gland**

   (c) However, the residues left behind are heavily acidic when reintroduced to water. This three-carbon compound is often used to decrease irritation and is also used in antifreeze.
   Answer: **Propylene glycol**

2. Identify some pathological mathematical objects, for ten points each.

   (a) This function mapping Reals to Reals takes the value 0 at all irrational values and the value 1/q at rational points p/q (where p/q is in lowest terms). Unlike Dirichlet's similar function, it is Riemann integrable and on the interval [0,1] it integrates to 0.
   Answer: **Tomae's Function**

   (b) This man, whose five axioms make up the modernly accepted definition of the natural numbers, created a space-filling curve, an early example of a fractal.
   Answer: **Giuseppe Peano**

   (c) It is easy to construct space-filling curves with extensions of mappings from this pathological set, which has the property of being uncountable, contained in the unit interval, and containing no open interval of any size. It is formed by removing the middle third from the unit interval, removing the middle third from the remaining pieces, and so on.
   Answer: **Cantor Set**

3. Although they cannot be produced by any concievable superconductor, it is thought that they could catalyze the decay of protons. For ten points each...

   (a) Name this object first proposed by Dirac conjectured to have $\frac{137}{2}$ times the charge of the electron.
   Answer: **Magnetic monopoles prompt on "monopoles"**

   (b) Because magnetic fields exist, at the beginning of the universe there could have been only so many monopoles. Give the name for the upper bound on the number of monopoles currently in the universe.
   Answer: **Chudakov-Parker bound**

   (c) On Valentine's Day 1982 Blas Cabrera of Stanford detected a single event that could have been a monopole using what device invented by James Zimmerman that uses a superconducting ring interrupted by a Josephson junction?
   Answer: **Superconducting QUantum Interferometer Device**

4. It's one of the few classes that has no complete problems. Answer these questions about that crazy class BPP for ten points each.

   10 BPP is defined as a probabalistic Turing machine that always gives an answer and the probability of that answer being right is greater than or equal to this value, allowing it to be boosted to be arbitrarily close to 1.
   Answer: $\frac{2}{3}$

10 In 1988, Zachos proved that if BPP contained this class, it contains the **entire** polynomial heirarchy. Likewise, Buhrman and Fortnow showed that if BPP contains this class, then RP is equal to BPP.
Answer: **Nondeterministic <u>P</u>olynomial time**

(a) Showing that BPP is equal to P would mean that this class defined by Les Valiant requires superpolynomial circuits. The complete problem for this class is the number of possible satisfying assignments to a 3CNF formula.
Answer: **<u>#P</u> (Sharp-P)**

5. One of the greatest achievements in math in the twentieth century is the classification of all finite simple groups.

10 One of the more surprising findings was the description of this largest of the sporadic groups.
Answer: **Fischer-Griess <u>Monster</u> Group**

10 In 1990, the classification was found to have a "small" 1196-page hole called the quasi-thin case; this mistake was plugged by Stephen Smith and this Caltech algebraist, who is working on the sixth of the twelve volume complete proof.
Answer: **Michael <u>Aschbacher</u>**

10 John McKay noticed the Monster Group's character table was related to elliptic modular functions, and in 1998, Richard Borcherds won the Fields Medal for proving what poeticly named conjectures?
Answer: **<u>Moonshine</u> conjecture**

6. Identify the following things about aquifers, for ten points each:

10 These springs are located at breaches in the confining layers of aquifers. The water is forced to the surface under its own lithostatic pressure from a downhill gradient.
Answer: **<u>Artesian</u> well/spring**

10 This is an aquifer confined along a streambed or bank that is hosted by unconsolidated sediment. An example is the Boyne in Ireland.
Answer: **<u>Riparian</u> Aquifer**

10 This equation models the lithostatic pressure gradients of an aquifer. It states that the flow rate equals the cross-sectional area times the piezometric water elevation divided by the distance between wells, or that the flow rate is proportional to the permeability.
Answer: **<u>Darcy's</u> Law**

7. Answer the following about quasi-particles in a crystal for ten points each.

10 What is the name given to the "hole" created by an electron in a crystal given enough energy to break from its ground state that acts like a particle with positive charge $+e$?
Answer: **<u>Exciton</u>**

10 Frenkel exitons are exitons where the separation from the exciton and the excited electron is less than this value, defined as the separation between crystal units.
Answer: **<u>Lattice constant</u>**

10 On the other hand, Wannier-Mott excitons occur in materials with small effective masses and large values of this constant, defined as the relative permittivity of a dielectric.
Answer: **<u>Dielectric constant</u>**

8. On a 5-10-15 basis, name the following relating to quirks of evolution.

5 Observed famously in Darwin's finches, this occurs when a small population of individuals carrying a small fraction of the genetic variation of a species colonizes a new area, leading to the over-expression of an allele.
Answer: **<u>Founder effect</u>**

10 This theory ascribed to Niles Eldridge and Stephen Jay Gould links rapid speciation periods like the Cambrian Explosion following periods called stases to individualized genetic effects operating in small populations.
Answer: **punctuated equilibrium, do not accept "saltation"**

15 Its two parts suggest that changes in one species imply some probability of extinction for another coevolved species, and that such coevolved system interactions lead to oscillations in genotype frequencies.
Answer: **Red Queen hypothesis or Van Valen's hypothesis**

9. It states that the static pressure plus one half times the density times the velocity squared plus the pressure due to gravity is a constant. For ten points each...

10 Give the name applied to this equation.
Answer: **Bernoulli's law**

10 Using Bernoulli's law, one can measure dynamic pressure using this device that combines a static-pressure tube and a Pitot tube named for German developer of lifting line theory.
Answer: **Prandtl's tube**

10 This device, shaped like two funnels put nozzle to nozzle, measures volume flow according to a namesake principle that states reducing cross-sectional area of a pipe creates a fall in static pressure that draws in liquid.
Answer: **Venturi principle**

10. In 1866 he proved that the second law of thermodynamics demanded that all molecular orbits must be closed and presented a formula derived from the principle of least action. For ten points each ...

10 Name this German physist better known for his definition of an entropy of a system given the number of reachable states.
Answer: **Ludwig Eduard Boltzman**

10 Attacked for using a mechanistic approach incompatible with irreversible processes, he later adopted this probabilistic hypothesis that states a closed system eventually enters all acessible states.
Answer: **Ergodic hypothsis (do not accept "Stofzahlansatz")**

10 This modern formulation can then be used to derive what equations governing incompressible fluids using the Chapman-Enskog expansion?
Answer: **Navier-Stokes Equations**

11. Identify these types of blood cells on a 5-10-15 basis.

5 Containing no hemoglobin, these are differentiated from their ruddy cousins in that they have a nucleus and exist both inside and outside blood vessels.
Answer: **White blood cells or Leukocytes**

10 These agranulocytes, named for the nodes where they are often found, stain with a huge nucleus and very little cytoplasm. They include B and T cells.
Answer: **Lymphocytes**

15 Somewhat larger that neutrophils, they are characterized by an abundance of coarse, refractive granules and increase in allergic conditions and during parasitic infestations but decrease during the Thorn test.
Answer: **Eosinophils**

12. Answer the following about active galactic nuclei, for ten points each:

10 The most common type of galactic center, they are characterized by their low accretion rates, and are believed to be an evolutionary link between normal galactic centers and active galactic nuclei.
Answer: **Low Ionization Nuclear Emission Regions**

10 These low energy gamma sources are classified into Type I or Type II infrared emitting, or X-ray emitting types that display a smooth emission continuum.
Answer: **Seyfert** Galaxies

10 Extended halos from other galaxies are thought to be one mechanism behind this large array of absorption lines at smaller red shifts that affects the emission spectra of quasars.
Answer: **Lyman Alpha Forest**

13. Given the chromosomal abnormality, give the disease for fifteen points. If you need more information, you'll only get five.

15 A partial deletion of the short arm of chromosme 5, usually *de novo*, although parental translocations cause about 10% of cases.

5 A distinctive cry, low birth weight, and hypertelorism and epicanthal folds characterize infants with this disease.
Answer: **Cri du Chat** or **Cat's Cry** or **Le Jeune**

15 Although it has been localized to the fibrillin gene on chromosome 15, each family's mutation is distinct, making early diagnosis difficult.

5 Individuals are tall and extremly thin, caused by abnormal connective tissue in the cardiovascular and musculoskeletal systems. The most common cause of death is dissection of the aorta.
Answer: **Marfan** Syndrome or **Arachnodactyly**

14. 1,3-hexadiene is, but 1,4-hexadiene isn't. For ten points each ...

10 When the two double bonds of a diene are separated by one single bond, they form what stable compounds?
Answer: **conjugated** dienes

10 This type of spectroscopy, whose working range is greater than 200 nanometers, is useful for finding conjugated double bonds because it is absorbed by pi electrons.
Answer: **U**ltra**V**iolet spectroscopy

10 This reaction between a conugated diene and an alkene won its namesakes the 1950 Nobel in chemistry.
Answer: **Diels-Alder**

15. Ester is a fine Chocobo kingpin, but the chemical of the same name is more interesting. Identify the following things related to esterification for ten points each.

10 The canonical example, Fischer esterification, involves the combination of an alchohol with this kind of acid, with a carbon single bonded to an hydroxyl group as well as doubly bonded to another lone oxygen, to for an ester.
Answer: **Carboxylic** axid

10 Unfortunately, the balance of the reaction can be heavily balanced in favor of the reactants, so one often removes some of the products. Sometimes a the system has this property, and an entrainer must be introduced to separate the mixture of materials with a constant boiling point.
Answer: **Aziotropic**

10 What special case of the reverse of esterification, hydrolysis, creates an alchohol from an oil or fat, for instance from lye and potassium hydroxide or from a corpse rotting in alkali earth.
Answer: **Saponification**

16. Answer the following about a layer of rock, for ten points each:

10 This omnipresent thin layer of clay separating its namesake coeval rock types is enriched in charcoal, tektites, and platinum group elements interpreted to originate with a meteorite impact believed to correspond to that of Chicxulub in the Yucatan which is linked to the destruction of the dinosaurs.
Answer: **Cretaceous/Tertiary** or **K/T Boundary**

10 In addition to the presence of platinum group elements like iridium, the Chicxulub site has been identified as an impact structure due to an abundance of this mineral produced in sandstones by pressures in excess of 75 kilobars at 300 degrees Kelvin. It is sometimes called "shocked quartz".
Answer: **Stishovite**

10 These eroded impact craters are produced by mass wasting along crater rims or by water action acting on one side of the structure. Chicxulub Crater is a buried one, though the more famous example is the Sudbury Crater in Ontario, which supplies about half the world's nickel.
Answer: **Astrobleme**

17. Since I must write a trashy science bonus, I may as well write a trashy earth science bonus. So choke on these questions about fictitious minerals, for ten points each:

10 A revolt led by Kuato disrupts the extraction from the Pyramid Mine of this mineral used to release breathable air and the building of space-based lasers on Mars. It is the mineral that keeps Vilos Cohaagen in power in Total Recall.
Answer: **Turbinium** ore or **turbinite**

10 Since it is resists gravity, it can be used as a shield that causes objects to float. Its namesake uses it to travel to the moon in H.G. Wells? *The First Men on the Moon*, and it is used for the same purpose in the *The League of Extraordinary Gentlemen* comics.
Answer: **Cavorite**

10 In the Star Trek universe, this is "pressed" into gold to give the worthless metal value and to serve as a means of exchange. Morn carries a fortune of it in his second stomach, and Rule of Aquisition 102 says that "Nature decays, but _____ lasts forever."
Answer: **Latinum**

18. It states that, for finite integrable functions with N variables, it doesn't matter which order you integrate over the space. For ten points each. . .

10 Name this theorem named for a Jewish Italian mathematician.
Answer: **Fubini**'s theorem

10 The Gaussian integral, $\int e^{-x^2}$, is not solveable by normal means, but one can consider the square in this coordinate space parameterized by r and θ and apply Fubini's theorem to find the answer.
Answer: **Polar**

10 This is the numerical result obtained by integrating e^{-x^2} from negative infinity to positive infinity.
Answer: $\underline{\sqrt{\pi}}$

19. Identify the following random things from taxonomy, for the stated number of points:

10 Outside of Linnaean evolution, these diagrams that describe the relationship between organisms that share an origin are used in place of paraphyletic taxa. Groups that possess or do not possess a given trait are listed as positive or negative and connected to their ancestors via "y-diagrams."
Answer: **Cladogram**

10,10 Apart from distance methods, when building a phylogenetic tree from genetic data, there are two primary ways of selecting the topology. One produces a tree with that requires the minimum number of changes and the other produces a tree that, given a model of mutation maximizes the probability of such a topology occuring. Name both for ten points each.
Answer: **M**aximum **L**ikelihood and
Maximum **P**arsimony

20. Identify the following things thought to be mediators of forces for ten points each.

   10 This zero spin particle is predicted by the standard model and has a theoretical mass upper bound of 251 GeV.
   Answer: <u>Higgs</u> *boson*

   prompt on "God" particle

   10 This particle discovered in 1937 by Street and Stevenson's cloud chamber was thought to be a particle predicted by Yukawa, but Bethe thought that it was just a massive version of the electron that might be a decay product of the Yukawa particle.
   Answer: <u>muon</u>**, grudgingly accept** $\underline{\mu\text{-meson}}$

   10 These spin one particles mediate the strong nuclear force between quarks in QCD theory.
   Answer: <u>Gluon</u>