Science Monstrosity III: The Gay Science
Round 1

Chicago
Seth Teitler, Selene Koo, Larry Wang, Mary Qiu, and others

July 2, 2005

1 Chicago Tossups, Round 1

1. If one knew the first n bits of Chaitin's problem, then one can solve this problem for all inputs of length less than n. The problem itself is recognizable, but its complement is not. A corollary of Rice's theorem concerning proper, non-empty subsets of partial functions can be used to prove that it's undecidable, but the usual argument is to consider a candidate Turing machine that computes the problem M and that, when called with the input M goes into an infinite loop if M halts. For ten points, name this first known undecidable problem, the question of whether, for given input, a given algorithm will complete or run forever.
Answer: **Halting problem**

2. Constructed from three small, flashing incandescent lamps arranged as a 'Y', this small device's inventor had the idea for it while hanging a clock in the bathroom and subsequently hitting his head on the sink. It requires 1.21 times ten to ninth Watts to operate, which has been variously supplied by plutonium, lightning, and Mr. Fusion. Situated behind the passenger seat of a Delorian – for ten points– what is this device that Doc Brown explains "makes time travel possible."
Answer: **Flux capacitor**

3. The snowplow and Sedov-Taylor phases are evolutionary stages in simple models of the expanding remnants associated with these events, which are thought to be the sites for acceleration of cosmic rays with energies up to about 1015 eV. The progenitor star can be a carbon-oxygen white dwarf in a semidetached binary system, in which case mass transfer past the Chandrasekhar limit is needed, or it can have an initial mass greater than about 8 solar masses. In the latter case, formation of an iron core is followed by the core-collapse phase of this process, accompanied by a flood of neutrinos. For ten points, name these powerful explosions which can leave neutron stars or black holes.
Answer: ***Supernovae***
accept supernova remnants until "remnants associated"

4. The Urysohn Metrization Theorem states that every topological space of this type is metrizable. For finite-dimensional inner product spaces, operators of this type have spectral decompositions. In a topological space of this type, disjoint closed sets can be separated by disjoint open sets. An operator of this type commutes with its adjoint, and a subgroup of this type is self-conjugate and can be used to form a quotient group. For ten points, give this term also used to refer to the Gaussian distribution, or to a vector perpendicular to a given surface.
Answer: ***Normal***
accept T4 before "operators of this type"

5. At 19.1 kb, its seven-gene genome is the largest of the negative-strand RNA viruses. Feldmann and Grolla of the CNML developed a mobile lab for quickly diagnosing this illness, and their associate Steven Jones has demonstrated an effective vaccine for this filovirus, although it does not work on humans. This will be too late, however, for Uige provence, which suffered from an outbreak earlier this year. The disease got its name when researchers contracted the disease from monkeys imported to labs in Yugoslavia and Germany. For ten points, name this viroid that, along with with Ebola, comprises the filovirus family.
Answer: **Marburg virus**

6. The hydrocarbon DMX, or 5-dehydro-m-xylylene, is the first organic triradical known to violate them, having an open-shell doublet ground state. They assume Russell-Saunders or L-S coupling, and result from spin-spin, orbit-orbit, and spin-orbit interactions. For two electrons, the symmetric triplet spin state forces the spatial portion of the total wavefunction to be antisymmetric, so that the electrons spend less time near each other, resulting in a lower-energy configuration. Thus, the spin-spin interaction dictates maximum total spin in the ground state. For ten points, name these rules which state that electrons are unpaired in orbitals within a subshell whenever possible, and that orbitals are filled first by electrons with parallel spins.
Answer: **Hund's rules, accept equivalents**

7. One group, Stylonichia, may have lost the namesake feature of this phylum through fusion into cirri. However, they still retain the characteristically strong network of sub-membrane microtubules. One of their unique features is their possession of a macronucleus and several micronuclei in each cell, which allows mixing of genetic material even though they reproduce by binary fission. For ten points, what is this subcategory of alveolata with namesake hair-like appendages for locomotion that are shorter than flagella?
Answer: **Ciliates or Ciliophora**

8. Multiple experiments to test whether it is always conserved were proposed by two physicists as a possible resolution of the tau-theta puzzle. The first experiment that proved that it is not always conserved observed anisotropy in the emission of electrons in beta decay of magnetically aligned cobalt-60 nuclei, and was led by Madame Wu. Laporte's rule, a statement of its conservation by the electromagnetic force, states that electric dipole transitions must connect states with different eigenvalues of the operator of this name. The operator of this name has 1 and -1 as its only eigenvalues, and corresponds to reflection through the origin. For ten points, name this property, thought to be conserved in combination with time reversal and charge conjugation, which can be even or odd.
Answer: **Parity**

9. This galaxy was home to supernova 1987A, as well as a giant HII (read: H 2) region known as the Tarantula Nebula. In the Revised Hubble Sequence, this late-stage galaxy is classified as an SBmIII (read: S B M 3) galaxy. This galaxy's companion, located in the constellation Tucana, is home to the Cepheid variables whose observation led Henrietta Leavitt to postulate the period-luminosity relationship. Until the discovery of the Sagittarius Dwarf Elliptical Galaxy, it was thought to be the closest external galaxy. For ten points, name this fourth most luminous member of the Local Group, which, like its less luminous companion, is named for an explorer.
Answer: **Large Magellanic Cloud**

10. It includes PDP10's, 370's, ALTO's and Dorado, but it does not contain RS232 and TELEX. While it includes the basic ARPANET transmission scheme, it does not include the ARPANET-IMP's VDH protocol. Although it includes the HDLC, it does not include the checksum, whose 16-bit value is sent in 16-to-1 order, which Danny Cohen termed a major coup for the Blefuscu camp. For ten points, name this bit organization strategy that first transmits the wide end of a word, aka the most-signifigant-bit, in contrast to the Lilliputian little-endian method.
Answer: **Big-Endian**

11. A linear continuum L in the order topology has this property, and so do intervals and rays in L. For a topological space X, the equivalence relation which holds for two points if they are both in some subspace with this property splits X into equivalence classes known as components. This property holds for a topological space if and only if it has no proper closed and open subsets. The general form of the Intermediate Value Theorem applies in the case of a continuous map to an ordered set in the order topology from a topological space with this property. For ten points, name this topological property which holds for spaces that cannot be expressed as the union of a pair of disjoint, nonempty, open sets, also known as a separation.
Answer: **Connectedness**

12. Laisvall type deposits hosted by this lithology serve as an evolutionary link between Mississippi Valley Type lead-zinc and Stratiform copper deposits, and another economically important variety hosts roll-front uranium-vanadium deposits. Rapid deposition in turbidity currents produces its graywacke (GRAY-wacky) variety, while disintegration of granite without appreciable chemical weathering produces the feldspar-rich type, arkose. Cross-bedding and rippling are two common formations in this rock type whose textural groups are the wackes (WACK-eez) and arenites. For ten points, name this sedimentary rock second in abundance to shale, which can form by lithification of dunes.
Answer: **Sandstone**

13. Trouton and Noble tested this hypothesis by charging and discharging a capacitor in a torsion pendulum at the natural frequency of the pendulum. A version of this hypothesis involving drag effects was found to

be inconsistent with the aberration of starlight. The Kennedy-Thorndike experiment discredited the drag version of this hypothesis, as well as a proposal made by an Irish physicist and the mentor of Zeeman in an attempt to explain the null result of an 1887 experiment that made use of a half-silvered mirror. The proposal was a contraction due to motion relative to the hypothesized medium, and the 1887 experiment was conducted by Michelson and Morley. For ten points, name this hypothesized medium for transmission of light waves.
Answer: Luminiferous ether or aether
accept ether drift until "name this hypothesized medium" has been read

14. The theorem that, in each deleted neighborhood of an essential singularity, a holomorphic function assumes values arbitrarily close to any given value, is due to this man and Casorati. He also proved the theorem that, for any continuous complex function on a closed real interval, there exists a sequence of polynomials that converges uniformly to the function on the interval. This theorem was later extended by Stone. A condition for uniform convergence is known as his namesake M-test, and he published the first example of a continuous function that is nowhere differentiable. He brought Kovalevskaya to Berlin, and supervised her work on mechanics. For ten points, name the German mathematician who developed the theorem that every subsequence of the real numbers contains a convergent subsequence with Bolzano.
Answer: Karl Theodor Wilhelm Weierstrass
accept Casorati-Weierstrass before "this man and Casorati"

15. Zeise's salt, the first isolated organometallic compound, exhibits this geometry also found in a zirconium-containing phosphonium ion that is an exception to the rules of Le Bel and van't Hoff. The trans effect strongly influences the rate of ligand substitution in these complexes often containing low-spin d8 metal ion centers. Conventionally the highest-energy antibonding d orbital is the x-squared-minus-y-squared orbital, and it can often be conceptualized as a tetragonal distortion of the octahedral geometry. For ten points, identify this geometry often exhibited by rhenium, palladium, and platinum-containing compounds such as cisplatin, which contain four ligands surrounding a central atom.
***Answer:* Square planar**

16. In some situations, the appropriate condition for determining whether this phenomenon will occur is that the entropy per unit mass decrease with radius, known as the Schwarzschild criterion. The extra efficiency of this process can be expressed in terms of the Nusselt number, and it can be treated approximately using mixing-length theory. The Rayleigh-Benard type establishes an adiabatic lapse rate, while situations with the forced type are characterized by Newton's law of cooling. Occurring above the critical Rayleigh number, for ten points, name this process of heat transfer by fluid motion.
***Answer:* Convection**

17. Gerold Schwarzenbach demonstrated how to use it as a titration agent for inorganic analysis in the 1940s, but it's also used in preventing degradation of DNA by inhibiting DNAse. Among its medical uses are in stimulating phosphorylase α activity in uterine tissue and – along with EGTA – in preventing stored blood from clotting by sequestering the calcium ions needed for coagulation. Synthesized industrially from formaldehyde, 2-aminoethylamine, and a cyanide source, this highly versatile chelating agent forms coordination complexes with most divalent and trivalent metal ions. For ten points, what is this acid, used commercially as a water softener, anticoagulant, a food and cosmetic preserver, and treatment for metal poisoning?
***Answer:* EDTA or ethylenediaminetetraacetic acid**

18. This region's lower boundary is conventionally taken to be the 1,300 degree Celsius isotherm. It contains two chemically distinct portions, with the lower portion consisting primarily of magnesiowstite and perovskite. Airy and Pratt gave different hypotheses for how this mechanical and thermal boundary layer maintains isostatic equilibrium with the layer below it, whose existence was suggested by observations of low velocity zones, suggesting plastic behavior. This layer cools primarily by conduction, and contains the Moho discontinuity. For ten points, name this rigid portion of the Earth which includes the uppermost mantle, and floats on the asthenosphere.
***Answer:* Lithosphere**

19. For the Potts model, this quantity is identical to the dichromatic polynomial of graph theory. In quantum field theory, this term refers to a functional integral involving the action functional which determines the correlation functions. In quantum mechanics, it can be defined as the trace of the exponential of the negative of the Hamiltonian over Boltzmann's constant times the temperature. In classical statistical mechanics, it can be expressed as the exponential of the negative of the Helmholtz free energy over Boltzmann's constant times the temperature. In number theory, it is the number of ways of writing an integer as a sum of natural numbers, ignoring order. For ten points, name this quantity, defined in statistical mechanics as the sum of the Boltzmann factors of a system.
Answer: **Partition function**

20. Igarashi [ee-GAHR-ah-shee] et al. reported a rise in this element's concentration in well water before the 1995 Kobe [koh-BEY] earthquake after seeing alpha particles released by Polonium, produced by its isotope with a half-life of 3.8 days. Less stable isotopes are thoron, discovered when Owens and Rutherford observed thorium evolving a (*) gas, and actinon, discovered when Giesel [gee-ZEHLL] and Debierne [dah-BEHRN] did the same with actium. First discovered in 1900 by Friedrich Dorn, when Radium-226 ejects an alpha particle it creates a colorless, odorless gas that is now recognized as the leading cause of lung cancer in American non-smokers. For ten points, name this radioactive noble gas with symbol Rn.
Answer: ***Radon***
prompt on "niton"

21. According to Cowling's theorem, it is impossible to have a system of this type that is self-sustaining and axisymmetric. The fast subtype have growth-rates that are independent of resistivity, and can operate even in the limit of perfect conductivity. The omega effect can act in systems with differential rotation to generate toroidal fields from poloidal fields. Systems of this type require a seed field, and become self-sustaining above the critical magnetic Reynolds number. A magnetic field generates a current which induces a reinforcing magnetic field in this sort of system, thought to explain the magnetic fields of most stars and the Earth. For ten points, what system shares its name for the device created by Faraday to create an electric current from mechanical force?
Answer: **Dynamo**

22. This genus, along with Corynebacteria and Nocardia, forms the CMN group. Their lipid cell walls have N-acetyl-muramyl-L-alanyl-D-isoglutamine, which inhibits macrophages. They produce dimycolates of trehalose, which makes them grow in serpentine cords. They are acid-fast and grow very slowly, with division times of up to five hours. One of its two species has never been cultured *in vitro*, but grows on the foot pads of armadillo, but the other is studied intently because of its profound effects as a respiratory ailment. For ten points, name this bacterial genus that contains the agents responsible for tuberculosis and leprosy.
Answer: **Mycobacteria or Mycobacterium, prompt on Mycobacteriaceae**

2 Chicago Bonuses, Round 1

1. Answer the following about potentials in electromagnetism, for ten points each...

   10 This man's potential for a free charge is proportional to the charge over the distance to the charge. This reproduces his one over r squared force law.
   Answer: **Charles-Augustin de Coulomb**

   10 This man's potential is a screened Coulomb potential. He predicted K capture and the existence of the pion.
   Answer: **Hideki Yukawa**

   10 The Coulomb gauge consists of setting this qunatity equal to zero.
   Answer: **Divergence of the vector potential**

2. Answer some questions about the prevention of autoimmune disease FTPE.

   (a) These cells, which turn into memory and plasma cells after activation, are responsible for directly effecting the humoral aspect of autoimmune diseases.
   Answer: **B-cells**

   (b) Each plasma cell churns out incredible amounts of one particular kind of these Y-shaped molecules whose arms attach to antigens.
   Answer: **Antibodies**

   (c) In an attempt to curb the tendency to autoimmune disease, B-cells and T-cells have these glycoproteins on the surface, for example, CD28 and B7. Only when these are presented does co-stimulation occur, and then T and B cells are allowed to start attacking antigen.
   Answer: **Co-receptor**

3. Give the following adjectives attched to Turing machines for ten points each.

   10 This adjective describes a Turing machine whose operation is not encoded in its description but is actually read in from the tape; this was the theoretical forerunner of software.
   Answer: **Universal**

   10 This adjective describes a Turing machine has more than one "next state" defined in its transition table. This word is also is the "N" in NP.
   Answer: **Nondeterministic**

   10 Consider all Turing machines that start with a blank tape and work for a really long time (or fill up a large number of spaces). Determining the most productive of these was shown to be rapidly intractable for reasonable numbers of states and alphabets by Tibor Rado.
   Answer: **Busy-beavers**

4. The 2-sphere is a crazy beast. For ten points each...

   10 This so-called paradox states that a ball can be dissected into a finite number of pieces which can then be reassembled, using rigid motions, into two balls of the same size as the original.
   Answer: **Banach-Tarski paradox**

   10 The hairy ball theorem states that, for any continuous tangent vector field on the sphere, there must be at least one point where this happens to the vector field.
   Answer: **Vanishes or goes to zero** accept equivalents

   10 This man's so-called paradox is the proof of the possibility of sphere eversion: it is possible to turn a sphere inside-out in 3-space without introducing a sharp crease at any point. He also proved the h-cobordism theorem
   Answer: **Stephen Smale**

5. Identify the following about folds in geology, for the stated number of points.

10 This term denotes a large downfold whose limbs are higher than its center that contains younger rocks in its central layers.
Answer: **Syncline**

5,5 Analogous to a fold's strike and dip, these two measures describe the fold's orientation in space. They are defined as the azimuth and inclination of the fold's hinge line. Name them for five points each.
Answer: **Trend and plunge**

10 In this stereographic projection of a fold's attitude, the fold's limbs are plotted as poles and fitted to a common great circle which represents the strike and dip of a plane perpendicular to the fold's hinge line.
Answer: **Pi diagram**

6. For ten points each, identify the following things that are in your mouth (or aren't, in the case of players from Arkansas).

10 This part of the gums is the tratified squamus epithelium that extends around each tooth and covers the inner aspect of the alveolar bone.
Answer: **Gingiva**

10 This hard covering of the crown in mammals is subject to hypocalcification when there is an excess of flourine in the diet.
Answer: **Enamel**

10 Harder than bone but softer than enamel, this yellow substance made from apatite crystals of calcium and phosphate.
Answer: **Dentine**

7. Answer the following questions about lightning, for ten points each...

10 Lightning that occurs above this 17 kilometer-high meteorological boundary in the atmosphere takes the form of Red Sprites or Blue Jets, and is caused by the ionization of nitrogen atoms.
Answer: **Tropopause**

10 This is the tendency for electrons to move towards warmer and thus less dense regions of ice crystals. It initiates charge separation and is a primary cause of lightning in cirrus spissatus clouds near the tropopause.
Answer: **Thermoelectric effect**

10 Because the ionosphere and the earth's surface form a resonating cavity, lightning flashes are observable as impulses on an SRS diagram due to this phenomenon that occurs at frequencies as high as 45 Hz.
Answer: ***Schumann resonance***
Do not accept "Alfven resonance," which occurs at less than 14 Hz

8. Name these Seidel aberrations in optics, for ten points each...

10 This aberration affects rays from points on the optical axis. The shape of the lens results in different focal points for rays entering the lens at different distances from the center.
Answer: **Spherical aberration**

10 In this aberration, different rays from an off-axis point contact the lens obliquely at different angles, focusing at different distances behind the lens. For a point source, this produces a bright point with a diffuse tail pointing away from the optical axis.
Answer: **Coma or comatic aberration**

10 In this aberration, rays from an off-axis point encounter a lens that is tilted, resulting in asymmetry about the lens axis and different focal lengths for rays with different orientations. At the inside and outside focal points, a point source is imaged as a line parallel to the weakest and strongest principal planes, respectively.
Answer: **Astigmatism**

9. Answer some questions about chundering, for ten points each.

10 These are defined as substances, usually injected or swallowed, that induce vomiting.
Answer: **Emetic**

10 This very well-known emetic, often used to treat poisoning as well as croup, comes from the roots of a tree whose name means "roadside sick-making plant", and is most common in Brazil.
Answer: **Syrup of Ipecac**

10 There are two alkaloids in ipecac that actually trigger the vomit reflex. Name either.
Answer: **Emetine or methylcephaeline or cephaeline or 6'-O-demethylemetine - yes, it's circular naming**

10. Stuff about rings, for ten points each...

10 This term is used to denote a ring if $x^2 = x$ for every element x in the ring.
Answer: **Boolean ring**

10 This is the term for a mapping from a ring R to a ring S that preserves the ring operations of R. The kernel of one of these maps is always an ideal of R.
Answer: **homomorphism**

10 This term denotes a commutative ring in which the product of two non-zero elements is always zero. The additional requirement that the ring contain a unit element different from zero is sometimes included in the definition.
Answer: **integral domain**

11. Stuff about gases, for ten points each...

10 This equation of state predicts a compressibility factor of $\frac{3}{8}$ at the critical point. It improves on the ideal gas law by introducing two constants expressing the strength of attraction between gas particles and the size of the gas particles.
Answer: **van der Waals equation of state**

10 This two-parameter equation of state predicts a compressibility factor of $\frac{1}{3}$ at the critical point. It is better at high pressures than the van der Waals or Peng-Robinson equation, but not as good as the Peng-Robinson equation in the liquid-vapor region.
Answer: **Redlich-Kwong equation of state**

10 First enunciated by van der Waals, this statement, that a universal equation of state can be obtained in terms of the reduced pressure, volume, and temperature, holds for both the van der Waals and Redlich-Kwong equations of state.
Answer: **Law or principle of corresponding states**

12. Given clues about a component of the universe, name it on a 15-5 basis.

15 The equation of state parameter for this component is 1/3, and its associated energy density goes as the redshift to the fourth power.

5 The pressure associated with this component is one-third its energy density, or one-third times temperature to the fourth power times the namesake constant.
Answer: ***radiation***
accept photons

15 The equation of state parameter for this component is -1, and its associated energy density is independent of the redshift.

5 Einstein introduced this component into the field equations for general relativity to allow for a static universe.

Answer: ***cosmological constant***

prompt on "lambda"

13. Name some household chemicals, where by "household" I actually mean laboratory for ten points each.

10 This buffer is the T in TBE, TAE, TBE, and TE buffers.

Answer: **Tris(hydroxymethyl)amino methane**

10 This very blue chemical is often used to stain protein gels. It's also used as the dye in the Bradford Assay.

Answer: **Coomassie Brilliant Blue or 2,7-Naphthalenedisulfonic acid or 4-(4-anilino-5-sulfo-1-naphthyl)-5-hydroxy-trisodium**

10 This is the possibly carcinogenic dye used to stain nucleic acids in agarose gels. It is a dark red-orange-brown color in solid form or solution, but glows under UV light.

Answer: **Ethidium Bromide or 3,8-diamino-5-ethyl-6-phenylphenanthridinium bromide or 2,7-diamino-10-ethyl-9-phenylphenanthridinium bromide**

14. Ah, VSEPR theory, the refuge of lazy question writers. Given a molecule, give the number of lone pairs it has and its VSEPR configuration for five points each.

5,5 Ammonia

Answer: **trigonal pyramidal and one**

5,5 Boron trichloride

Answer: **trigonal planar and none**

5,5 Water

Answer: **bent (don't accept "linear") and two**

15. Answer the following on ordinary differential equations, for ten points each...

10 The existence-uniqueness theorem for ODEs makes use of this condition, satisfied by a map f between metric spaces if for all x and y, there is a positive constant L such that the distance between $f(x)$ and $f(y)$ is always less than L times the distance between the x and y.

Answer: **Lipschitz condition or continuity**

10 ODEs of this type have the property of superposition. An ODE of this type can be written as a sum of terms involving a coefficient times the dependent variable or some derivative of the dependent variable, plus possibly some function of the independent variable.

Answer: **linear**

10 For a system of n linear ODEs, a set of n solution functions can be tested for linear independence using this matrix, whose i^{th} column consists of the ith solution followed by its first $n-1$ derivatives. The solutions are linearly dependent if and only if the determinant is zero.

Answer: **Wronskian matrix**

16. There are thousands of gaps in Saturn's rings. Identify these famous ones from the moon that sweeps them out for fifteen points each or for five if you need more information.

15 Mimas

10 Located between the A ring and the B ring, this division gets its name from its discoverer, a Italian-French astronomer.

Answer: **Cassini Division**

15 Pan

10 Located within the A ring, it is the namesake of a 19th century German. Recent images from the Cassini probe have shown that there is a thin knotted ringlet within the division.
Answer: **Encke Division**

17. Math stuff in classical mechanics, for ten points each. . . .

10 This transformation between sets of independent variables can be used to convert between the Lagrangian and the Hamiltonian. It can also be used to transform between thermodynamic potentials.
Answer: **Legendre transformation**

10 This theorem states that systems evolving under Hamilton's equations preserve volume in phase space.
Answer: **Liouville's theorem**

10 These bilinear forms obey Jacobi's identity. If the inputs are two integrals of motion, the output is also an integral of motion. If the inputs are the Hamiltonian and a generalized coordinate or momentum, the ouput is the time derivative of the generalized coordinate or momentum.
Answer: **Poisson brackets**

18. His name is attached to logical statements where all existential quantifiers precede all universal quantifiers. For ten points each. . .

10 Name this 20^{th} century Norwegian mathematician.
Answer: **Thoralf Skolem**

10 Skolem and Leopold Löwenheim also proved that if any formal system has a model, then that model has this property, meaning that it can be placed in correspondence with the integers.
Answer: **countable or cardinality of $\aleph_0$**

10 Skolem also proved that $2^n - 7 = x^2$, an equation of this type mentioned in Hilbert's 10^{th} problem, does not have a solution for $n > 15$, thus confirming Ramanujan's square equation conjecture.
Answer: **Diophantine**

19. Identify the following concept from computational geometry on a 30-20-10 basis.

30 Wolfram presents a $k = 3, r = 1$ cellular automaton that computes it in $1D$. Shamos and Hoey proved the first $O(n \log n)$ algorithm in 1975, and Fortune's sweep-line algorithm is the most widely used solution today.

20 Sometimes called the Dirichlet tessellation, it is the dual of the Delauny triangulation.

10 It is defined as a partition of space around n points such that any position in the cell is closer to the one and only one point inside the cell.
Answer: ***Voronoi diagram***
accept "Dirichlet tessellation" on the 30

20. Name these approximations and techniques useful in quantum mechanics, for ten points each. . .

10 This approximation method for calculating scattering amplitudes consists of expanding the scattering wave function in powers of the interaction potential. It is especially useful when the incoming plane wave is not substantially altered by the scattering potential.
Answer: **Born series or Born approximation**

10 The Born-Oppenheimer approximation is a special form of this approximation, which states that a particle initially in the nth eigenstate of an initial Hamiltonian will evolve into the nth eigenstate of a final Hamiltonian, if the transition from the initial Hamiltonian to the final Hamiltonian is slow.
Answer: **Adiabatic approximation or theorem**

10 This technique gives an upper bound on the ground state energy of a system by minimizing the expectation value of the Hamiltonian using a trial function with one or more adjustable parameters.
Answer: **Variation or variational principle or technique**