

Science Monstrosity III: The Gay Science
Round 5

Princeton
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July 2, 2005

1 Princeton Tossups, Round 5

1. Newton thought it was impossible to eliminate, but Euler presented the macula lutea as an example of a system that counteracts it. Chester Moor Hall's invention of a crown and flint system – later patented by John Dollond after a legal struggle – proved that not all glass had the same index of refraction, as Newton argued, and that putting a concave lens after a standard lens would allow different wavelengths to experience the same amount of refraction. For ten points, identify this type of aberration where different colors have different focal points.

Answer: Chromatic aberration

2. Its modern form is the n -dimensional analogue of the fundamental theorem of calculus, stating that the integral over the boundary of a region R of a chain Γ equals the integral over the region R of the exterior derivative of Γ . More well-known, however, is the classical form, stating that the integral – over a region R – of the curl of a vector field F dotted with the normal vector n equals the integral – over the boundary of R – of F dotted with the tangent vector t . For ten points, name this theorem of multivariable calculus, which can also be used to derive the special-case theorems of Gauss and Green.

Answer: Stokes's Theorem

3. It was first studied because of Ivar Giaever's experimental results of single-particle tunneling. Bardeen argued incorrectly that Cooper Pairs could not jump across the oxide layer from Giaever's experiments, but its formulator showed the flaw in Bardeen's calculations. It was experimentally verified by Philip Anderson and John Rowell, who published their paper in 1963. Frequently applied to create fast switches in computers, this is, for ten points, what effect in which a supercurrent appears across a thin insulating layer between two superconductors, a result of electron tunneling?

Answer: Josephson effect/tunneling

4. One example of this process is identified by fortification zoning in the crystals of dolostones, by which trace elements become emplaced on advancing edges of lattice boundaries. It may also generate dissolution features such as stylolites, and in organic-rich rocks it initiates the production of kerogen and bitumen. In paleomagnetism, it imparts a rotation from initial magnetic grain orientation known as compaction shallowing, and causes grain size to coarsen during aggrading neomorphism below 200 degrees Celsius. On geologic maps it is indicated by isopach widening in the direction of increasing pressure as burial and cementation eliminate porosity. For ten points, what is this geologic process by which loose sediments lithify into sedimentary rocks?

Answer: Diagenesis or diagenetic processes

prompt on "lithification" before it's mentioned

5. Two keywords added by John Reppy for his Exene project are "spawn" and "forever" for a concurrent version. Along with its creator, Tofte, Harper, and MacQueen provided a formal definition of it that allows people to prove mathematical properties; this definition is made easier by its strong type system and the distinction between identifiers and variables. Available in such derivatives as the Categorical Abstract Machine Language and the Standard version of New Jersey, for ten points, name this language created by Robin Milner as LCF's meta-language.

Answer: ML

accept "meta-language" before it's mentioned

6. This remainder, as well as Lagrange's, are both special cases of the Schlömilch Taylor Series Remainder. Together with Euler, it describes a differential equation of the form $ax^2 \frac{d^2x}{dy^2} + bx \frac{dx}{dy} + cy = 0$. With Riemann, it names the two equations: Partial of u with respect to $x =$ partial of v with respect to y and Partial of u with respect to $y =$ negative partial of v with respect to x , which describe the behavior of analytic functions. For ten points, give this name which also describes any sequence of p 's such that, for ϵ greater than zero, there is a large N such that the distance between p_n and p_m is less than ϵ if n and m are both greater than N .

Answer: Cauchy

7. Inelastic neutron scattering spectroscopy has revealed that packing inefficiencies caused by sublattice distortions in trigonal systems may be caused by a magnetic version of this effect. Metallocene ions, especially those involving d^7 or low-spin d^5 systems, exhibit a notably strong example, and in its best studied example it is seen as an elongation of one of the axes of an octahedron. Responsible for the blue color of copper (II) hydrous complexes, for ten points, what is this splitting of energy levels in non-linear ions, an elimination of degeneracy resulting in the distortion of molecular geometry in coordinate systems?

Answer: Landau-Jahn-Teller Effect

8. Of the eighteen known varieties, most use the Jak-Stat pathway. Type two is approved as a cancer treatment, and is being investigated as a potential AIDS therapy. Type one promotes hematopoiesis, type eleven is found in stromal cells, and activated T-cells produce type nine. Th2 cells can make three, four, or five. Neutrophils like eight, while CD8 cells make sixteen in order to attract CD4 cells. Conversely, the inflammatory and immune response are inhibited by type ten. Eosinphils and allergies involve five. For ten points, this describes the numbering scheme of what class of cytokines that specifically acts between leukocytes?

Answer: Interleukin

9. The damage caused by this phenomenon may be worsened due to shearing by mountainados which may accelerate the spread of so-called * sundowners. They are distinguished by a katabatic regime similar to that of the zonda and bora, and their onset is sometimes marked by the development of altostratus rotor clouds over Cajón Pass. They result from the simultaneous development of anticyclonic Great Basin high and weak offshore low pressure systems, and adiabatic compression produces their characteristic temperature. For ten points, name these dry foehn winds that contribute to the flammability of their namesake mountain range as they descend from the Mojave Desert to the Pacific Ocean.

Answer: Santa Ana winds

accept "Föhn Wind" before asterisk, otherwise prompt until it is mentioned

10. In two subfamilies of this order, Panurginae and Anthophorinae, the scopa is enlarged on the fourth tibiae. In halictines, the scopa is part of a larger structure called the corbicula, while in Hyaleinae microgametophytes from flowers are carried directly in the digestive track. The two suborders, symphtha and apocrita, are distinguished on whether their junction between the thorax and abdomen is constricted, giving wasps their distinctive appearance. For ten points, give the name for this "membranous-winged" order of insects that includes bees, wasps, and ants.

Answer: Hymenopterans

11. They can undergo the Pinacol rearrangement, yielding a carbonyl and a molecule of water. They can be created by opening an epoxide ring under acidic conditions while using water as a nucleophile. They can undergo oxidative cleavage with periodic (PER-iodic) acid to give two carbonyls. Potassium permanganate is used under aqueous alkaline conditions to form them from alkenes, but overoxidation is a common problem. The third way to make them is using osmium tetroxide to oxidize alkenes. For ten points, name compounds with hydroxy groups on adjacent carbon atoms.

Answer: Glycols, prompt on Diols

12. It uses two augers: one vertical - in early setups it was a series of paddles connected to a conveyer belt - to transfer waste into the two-ton storage tank and one horizontal to collect the waste behind the primary blade. The rest of the conditioner consists of a towel that's constantly moistened with 140° water that spreads evenly over the newly shaved surface before cooling. After Sonja Henie bought two for herself in 1950, it quickly became the standard, and was used in the 1960 olympics. For ten points, name this device that resurfaces ice for skating.

Answer: Zamboni

13. Sandage pointed out that it was off by a factor of 5 to 10 in 1958 because its first evaluation, in 1936, used Vesto Slipher's evaluation of the apparent luminosity of a cluster rather than an individual star. Current estimates using gravitational lenses and the "distance ladder" method using Cepheid variables pin the value around 70 kilometers per second per megaparsec, which corresponds to a universe that is 15 billion

years old. For ten points, identify this ratio of the relative speed of galaxies to their distance from one another.

Answer: Hubble number or constant or ratio

14. With Hsp27, Bortezomib works by inhibiting this protein complex, making it a treatment of multiple myeloma. It also causes proteolytic removal of immature cystic fibrosis transmembrane conductance regulator. It produces short polypeptides and amino acids from proteins that have been tagged by ubiquitin, allowing the cell to destroy endogenous proteins that are not needed, have been manufactured incorrectly, or have passed their lifespans. For ten points, identify this non-lysosome dependent, ATP-dependent, barrel-shaped protein complex with a 20S core and two 19S caps, that help keep a cell tidy.

Answer: 26S Proteasomes or 26S proteolytic complex

15. Their presence in ethers can be detected by shaking with 10% potassium iodide solution and checking for a yellow color. They can be used to reverse the stereochemistry of HBr addition, and a light source speeds the addition reaction, which supports the theorized free radical mechanism. They should be removed via reduction by lithium aluminum hydride because they are explosive when heated; an explosion of the hydrogen variety of this compound was responsible for the Kursk disaster. One common type of them is degraded in the presence of catalase into water and oxygen. For ten points, name these compounds containing two oxygens each bound to one another, such as H_2O_2 .

Answer: Peroxides

16. By equating linear function $I = \frac{kT}{Mw}\alpha - \frac{H}{w}$ to the Langevin function, there are two solutions: O and P . This is the condition where the two solutions are identical. Equating the gradients, we obtain that $\Theta_f = \frac{NM^2}{3k}$ or, using the Brillouin function, $\frac{NM^2w}{3k}$, making it a good measure of the molecular field coefficient. Alternatively, one could extrapolate from the asymptotic linear form of the reciprocal-susceptibility curve and use the value where it becomes zero. Above it, thermal vibrations destroy domains, making a material purely paramagnetic. For ten points, identify this temperature, approximately 1063K for iron, after which a ferromagnetic material loses its magnetization.

Answer: Curie-Weiss Temperature/Point

17. Robert Nemiroff has proposed that a gravitational lensing effect utilising it may provide the mass of MACHOs, though this phenomenon is usually an impediment to the resolution of multi-body problems such as the Struve-Sahade effect. One of the first modern methods for determining it was proposed by Halley, but his method is commonly unsuccessful due to the black drop effect. It may be computed via the exponential of the difference between apparent and absolute magnitude minus 5 over 5. However, it is the method of Bessel, who determined it for 61 Cygni, that remains the standard. For ten points, name this apparent change in a star's position caused by the changing angle subtended by the radius of the earth's orbit at its distance from the star.

Answer: Parallax

18. 5-aminolaevulinic acid is one of two main precursors to the substance that causes this uncommon disease. Its varieties include erythropoietic proto-, cutanea tarda, plumbic-, variegate, and acute intermittent types. In an acute attack, abdominal pain and fainting are caused by peripheral neuropathy, which also leads to panic attacks, paralysis, and delusions. Light sensitivity leads to easily blistered and scarred skin. Tetrapyrroles such as heme build up in the blood because of improper processing of ALA and/or porphobilinogen. For ten points, name this disease that might have contributed to the vampire myth because light-shy sufferers might treat themselves by drinking blood whose most famous victim was George III.

Answer: Porphyria

19. For any n with this property and any prime divisor p , $\frac{p^{en-e}-1}{p}$ is an integer only if $e = 0$, which proves half of Korselt's criterion: for every prime divisor p of an odd number, p^2 does not divide n and $p - 1$ divides $n - 1$. Alford, Granville, and Pomerance proved that there are infinitely many of them, as conjectured by their namesake in a 1910 paper. The smallest one is 561, and they have the interesting property that $a^n \equiv a \pmod{n}$ for all a less than n . For ten points, give these numbers that can fool primality testers

based on Fermat's little theorem.

Answer: Carmichael numbers

20. His name is attached to the energy where the coupling constant of a field theory becomes infinite. It is also attached to the damping of waves whose wavelengths are comparable to the Debye lengths as they travel through a uniform plasma with no magnetic field. Convinced to head the theory division of the Vavilov Institute by Kapitsa, the discoverer of superfluid Helium, this man's explanation of that superfluidity earned him the 1962 Physics Nobel. For ten points, name this Soviet-Armenian theoretical physicist, the author of *Course of Theoretical Physics*.

Answer: Lev Davidovic Landau

2 Princeton Bonuses, Round 5

1. Give the organic chemistry group, for ten points each.
 - 10 These are also called mercapto groups; it's in the R-group of cysteine.
Answer: sulfhydryl
 - 10 This is a simple substituted ketone or aldehyde, and its carbonyl carbon is commented with the rest of the molecule. They can be attached to benzene in the presence of AlCl_3 .
Answer: acyl
 - 10 This has the formula CH_2CH , and when not a group, is usually found as a radical in polymerization reactions to form plastics.
Answer: vinyl, do not accept vinylic
2. My quantum mechanics prof once told us that $3\pi = 10$. For ten points each, answer some questions about some other useful quantum approximations.
 - 10 Since in an atom the electrons move about 1000 times faster than the nucleus, it states that you can decouple the motion of the electrons and nucleus, thus simplifying the Schrödinger equation.
Answer: Born-Oppenheimer Approximation
 - 10 This theorem basically says that, once the distribution of the electron clouds has been determined with the Schrödinger equation, the forces of the electrons can be determined using classical electrostatics with a probability distribution of negative charge.
Answer: Hellman-Feynman theorem
 - 10 This broad class of approximations starts by selecting a simple H_0 and then adding in an H_1 that disturbs the system and imparts properties known to exist in the overall system $H = H_0 + H_1$.
Answer: Perturbation theory
3. Give the number of chromosome pairs of the following organisms for five points each if you're within two and ten points if you're exact.
 - 5,10 Human
Answer: 23
 - 5,10 Fruit Fly, *Drosophila melanogaster*
Answer: 4
 - 5,10 Mouse, *Mus musculus*
Answer: 20
4. Name the pair of stereochemistry notation terms for ten points each.
 - 10 This indicates whether two substituents are on the same or the different side of a double bond.
Answer: Cis, Trans
 - 10 This requires assigning relative priorities to the two groups on each carbon of a double bond. It indicates whether the two groups of higher priority are on the same or different side of that double bond.
Answer: E, Z or Cahn-Ingold-Prelog (so, not a doublet, but what the hell)
 - 10 This is useful to describe the reaction of a cis-alkene with a diene. It indicates whether the alkene substituents are cis or trans to the diene substituents.
Answer: Endo, Exo
5. Identify the following about a popular compression algorithm for ten points each.

- 10 This compression algorithm, presented in 1977 by its two authors and later extended by Terry Welch, works breaking up the bit stream into segments such that each segment is not a substring of the previous characters; each such segment then receives a code word.
Answer: Lempel-Ziv-(Welch)
- 10 The LZW algorithm, patented by Unisys, became infamous because Bob Berry at CompuServe used it in what graphics file format whose commercial users later got invoiced by Unisys?
Answer: Graphics Interchange Format
- 10 LZW is useful in information theory because the length of the LZW encoded string divided by the length of the original string converges to what value as the length of the string goes to infinity?
Answer: entropy of the information source (prompt on h)
6. Identify these types of mimicry for ten points each.
- 10 In this type of mimicry, a non-poisonous species develops similar markings to a poisonous animal to increase their survival.
Answer: Batesian mimicry
- 10 In animals such as coral snakes, this is a combination of Müllerian mimicry and Batesian mimicry where highly poisonous animals have the same coloring as slightly poisonous animals which have the same coloring as non-poisonous animals. In time, the palatable and deadly animals come to resemble the slightly poisonous animal.
Answer: Mertensian mimicry
- 10 Even though no predator species are involved, Wolfgang Wickler gave this term to the mimicry evidenced by *Haplochromis*, where the male's tail fin resembles the female's eggs. Since the female evolved mouth-brooding, this is needed to allow the eggs to be fertilized.
Answer: Intraspecific mimicry
7. Name the gene involved in cancer, for ten points each.
- 10 This is the "guardian angel" of the genome. It prevents cell division, causes apoptosis if a cell takes DNA damage, and can repair damaged DNA. It is mutated in the majority of cancers.
Answer: TP53
- 10 This is a tumor suppressor, whose loss most famously results in children with tumors in both eyes.
Answer: Retinoblastoma 1
- 10 Of the four genes in the Rous sarcoma virus, it is the only one not required for the virus to function. This tyrosine kinase like that found in many genomes, however, gives RSV its
Answer: V-src, prompt on "src," but don't accept C-src, the normal equivalent
8. For ten points each, name these mathematical terms all of which begin with the letter "A."
- 10 This noted Austrian Algebraist has two famous conjectures named after him. The first concerns his namesake L-function, while the second states that the set of primes for which a given integer is a primitive root has density equal to his namesake constant.
Answer: Emil Artin
- 10 This extremely fast-growing function was the first to provide a negative answer to the question "Are all functions primitive-recursive?" It is usually symbolized with an α or a large "A."
Answer: Ackermann's Function
- 10 A commutative group is called this, named for a Norwegian mathematician.
Answer: Abelian
9. Identify these ultra rare minerals for ten points each.

- 10 Notable for its extreme rarity, some well known mines include Rura Penthe, Remus, and Rigel 12. Less of a commodity once it became known how to recrystallize it, the first known recrystallization occurred in San Francisco during 1986.
Answer: Dilithium crystals
- 10 First developed for use by Myron McClain, once hardened, it can only be shaped by the use of a molecular rearranger. McClain created a disc of an alloy of it with vibranium, but was unable to replicate the experiment.
Answer: Adamantium
- 10 Also known as the shaving cream atom, its only known source is the Planet X, which was destroyed during a scuffle between Marvin the Martian and Duck Dodgers of the $24\frac{1}{2}^{th}$ century. It also makes a pretty powerful explosive, apparently.
Answer: Illudium Q-36
10. Answer the following questions on number theory for ten points each.
- 10 The claim that, for $n > 1$, there is a prime number between n and $2n$ is called this man's postulate, and was proven by Chebyshev in 1850, giving it its alternate name of Chebyshev's Theorem.
Answer: Bertrand's Postulate
- 10 An extension of Bertrand's Postulate is this theorem, which states that the product of R consecutive integers greater than k is divisible by a prime greater than k . It is named for a mathematician who, upset that only Newton could ever have a law of inertia, called one of his theorems in Linear Algebra an Inertia Law.
Answer: Sylvester's Theorem
- 10 According to the prime number theorem, the number of primes less than a given number x is asymptotically bounded above and below by a function of what order?
Answer: $\frac{x}{\ln x}$ or $\frac{x}{\log x}$ or $\frac{x}{\log_b x}$, with whatever base they want
11. Identify the following computer science terms that have been borrowed the liberal arts for fifteen points each or for five if you need an easier clue.
- 15 This problem proposed by Lamport in 1982 requires that all non-faulty components carry out the same instruction. With unsigned messages, there is no solution if more than one third of the components are faulty, but there is a general solution for signed messages.
5 Belisarius was one, but he was more loyal to Justinian than the ones that model sensor networks.
Answer: Byzantine generals (accept equivalents)
- 15 This search strategy proposed by Glover and Laguna works, in contrast to annealing and genetic algorithms, by incorporating a memory to decrease the probability of revisiting unproductive search strategies and increase the probability of adapting successful search strategies.
5 Freud paired them with Totems in a 1913 work that attempt to trace the genesis of civilization.
Answer: tabu
12. Answer some questions on Imaginary Quadratic Fields for ten points each.
- 10 The simplest Imaginary Quadratic Field is \mathbb{Q} adjoin $\sqrt{-1}$, and the ring of algebraic integers in this field is named for this great German algebraist.
Answer: Carl Friedrich Gauss (they're called the "Gaussian integers")
- 10 Gauss showed that, for $d = \{-1, -2, -3, -7, -11, -19, -43, -67, -163\}$, the ring of algebraic integers in the Imaginary Quadratic Field \mathbb{Q} adjoin \sqrt{d} is a unique factorization domain. The first proof by Heegner was not accepted, but these two men independently showed in the 1960s that those are the only such values d .
Answer: Alan Baker and Harold Stark

- 5,5 The ring of algebraic integers in an Imaginary Quadratic Field forms a lattice, with a fundamental region of either of two shapes. Name them both, for five points each.
Answer: rectangle and isosceles triangle
prompt on more general answers like “quadrilateral” or “triangle,” don’t accept more specific answers like “square”
13. Formed from fast moving lava, it’s the most abundant rock type in the outer 10 kilometers of Earth’s crust. For ten points each. . .
- 10 Name this extrusive igneous rock characterized geochemically as tholeiitic, alkaline, or calc-alkaline.
Answer: basalt
- 10 Very rapid quenching of basalt or dolerite along conduit margins forms this vitreous type of obsidian rock common in the vesicular matrix of scoria.
Answer: tachylyte
- 10 This is the intrusive or hypabyssal equivalent that forms when rock of basaltic chemistry cools under the surface.
Answer: gabbro
14. Funny feeling in your gut? Well, it might not just be because you skipped breakfast. For ten points each, name the following things that could be wrong with you.
- 10 If your mouth and throat are also dry and you ate some sketchy food, then you might be suffering from this paralytic enterotoxin that inhibits the release of acetylcholine.
Answer: Botulism or Clostridium botulinum toxin
- 10 If you just got back from the Caribbean or southern Asia, the *Aedes aegypti* mosquito might have given you this flavivirus.
Answer: Dengue Fever or Breakbone or Dandy or Duengero or Seven-Day Fever
- 10 Sometimes accompanied by megaloblastic madness, when the liver runs out of B12, this condition can be diagnosed by the Schilling test.
Answer: Pernicious/Addisonian/Primary/Cytogenic/Biermer Anemia
15. 1932 was a grand year. Urey discovered deuterium, Walton and Cockroft built a particle accelerator, and four experiments demonstrated a new particle. Answer the following questions about it on a 15-10-5 basis for ten points each.
- 15 In 1930, Bothe and Becker found that α -rays hitting beryllium were generating stronger ejected particles than expected. However, a later experiment with a larger quantity of polonium showed that these weren’t “ γ -rays” as expected, but preferentially scattered protons from water or paraffin. Name either of the experimenters.
Answer: Irène Curie or J. Frédéric Joliot
- 10 This scientist determined that it wasn’t a 50 MeV γ -ray but instead a particle, as predicted by Compton scattering, with equivalent mass to the scattered particles.
Answer: James Chadwick
- 5 This was the name given to the uncharged particle of mass roughly equal to the protons.
Answer: Neutron
16. He placed a rotating vulcanite disk 21.1 centimeters in diameter and half a centimeter thick and measured the magnetic field. For ten points each. . .
- 10 Name the American experimentalist who conducted the experiment and who also perfected the diffraction grating.
Answer: Henry Augustus Roland

- 10 This demonstrated that a moving, electrically charged object generates a magnetic field, thus showing that electric fields obey this relativistic transformation named for a 1902 Nobel winner.
Answer: Lorentz Transformation
- 10 The experiment was conducted while Rowland was working in this physicist's lab at Berlin University. His name is also attached to an important setup of two parallel coils separated by one fifth of their diameter to produce nearly uniform magnetic fields.
Answer: Hermann von Helmholtz
17. Answer some questions on a type of string theory for ten points each.
- 10 It was initially developed in 1921 to unify General Relativity with Maxwell's Equations, which it did by adding an extra spatial dimension. Later versions have added a number of other extra compact dimensions, all of which are "curled up" to the Planck length.
Answer: Kaluza-Klein Theory
- 10 Early extensions of Kaluza-Klein theory failed to account for this property, the constant left- or right-handedness of some fermions, since the extra dimensions are all symmetric with respect to left- and right-handed spinning particles.
Answer: chirality
- 10 Chirality was shown to be a problem by this string theorist currently at the Institute for Advanced Study in Princeton, who was also the first to propose M-Theory in 1995.
Answer: Edward Witten
18. Come back, Zinc, come back! Answer the following about everybody's favorite element, zinc.
- 10 Zinc was rediscovered in Europe by Maggraf in 1746, who showed that it could be obtained by reducing it with charcoal from this zinc silicate, sometimes used as a topical skin treatment.
Answer: Calamine
- 10 Although not ferromagnetic itself, when combined with this element with atomic number 40, Zinc become ferromagnetic.
Answer: Zr or Zirconium
- 10 These motifs, consisting of two β sheets with cysteine residue and an α helix with a histidine residue, bind zinc ions and take their name from a structural resemblance to a body part. They are often found in DNA-binding proteins.
Answer: Zinc fingers
19. Given the steps in a thermodynamic cycle, give its name for ten points each.
- (a) adiabatic compression, isochoric heating, isentropic expansion, and isochoric cooling
Answer: Otto
- (b) Isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression
Answer: Carnot
- (c) isothermal compression, isochoric heating, isothermal expansion, and isochoric cooling
Answer: Sterling
20. Some of the Messier objects have some pretty interesting names. Identify them by their name or be boring and give their Messier or NGC number for ten points each.
- 10 Numerically the first Messier object not on the listing, we view it six degrees south of its equatorial plane, giving it the appearance of flattened disc sitting below a central halo.
Answer: Sombrero galaxy or M104 or NGC 4594

- 10 The brightest galaxy in the infrared, it is located in Ursa Major. It appears as a long streak, and is classified as Irregular-II, meaning it has no internal organization.
Answer: Cigar galaxy or M82 or NGC 3034
- 10 This object in Taurus discovered by John Bevis is thought to be the remnants of a 1054 supernova.
Answer: Crab nebula or M1 or NGC 1952