

Science Bee – Final Round

Regulation Tossups

(1) One of these phenomena is bounded to the west by a system called the Kuriosho. Five major examples of these phenomena exist on Earth, which are driven by (+) Ekman transport and bound entities such as the Sargasso Sea in the Atlantic Ocean and the Great Pacific Garbage Patch. The "Canary" and Gulf Stream partially bound one of these formations, which is named for the (*) North Atlantic and caused by the Coriolis force. For the points, name these groups of ocean currents with a circular route.

ANSWER: ocean **gyres** (accept North Atlantic **Gyre**; accept North Pacific **Gyre**; prompt on "current" or "ocean current")

(2) Two stars within this constellation, Aspidiske and Avior, form the False Cross asterism, alongside Kappa and Delta Velorum. This constellation also contains the Diamond Cross asterism, which is made up of stars like (+) Miaplacidus. This constellation includes the Homunculus and Keyhole nebulas and formed the southern foundation of the former single constellation (*) Argo Navis. For the points, name this constellation, whose star Canopus is the second-brightest in the night sky and whose name is Latin for the keel of a ship.

ANSWER: **Carina**

(3) Walther Ritz proposed a combination principle partly named for this person, who also names a unit of energy equal to about 13.6 electron-volts. This person names a formula which, for the (+) hydrogen atom, states that "one over wavelength equals a constant times the difference in the reciprocals of squares of the principal (*) quantum numbers." For the points, name this Swedish scientist who names a formula which generalized the Balmer and Lyman series and allows for the calculation of spectral lines.

ANSWER: Johannes **Rydberg** (or Johannes Robert **Rydberg**; or Janne **Rydberg**; accept **Rydberg**-Ritz combination principle; accept **Rydberg** formula)

(4) A cell involved in this process expresses CatSper calcium channels to maintain rheotaxis. Multiple instances of this process are prevented by a "fast block" and a "slow block" that happen when the (+) cortical reaction releases proteases that harden the vitelline envelope. Enzymes released from the acrosome break down the zona pellucida during this process, which in humans, occurs in the (*) fallopian tube and is followed by uterine implantation. For the points, name this process in which a sperm cell fuses with an egg to form a zygote.

ANSWER: **fertilization** (accept **syngamy**; prompt on "sexual reproduction" or "sex")

(5) **In the second book of their most famous work, this person explained that the light reflected from an object is modified by its color. In that same work, this person built on Ptolemy's work concerning binocular vision to coin the term (+) "horopter."** This person lends his name to a problem which concerns reflection in a spherical mirror. (*) For the points, name this Islamic mathematician whose *Book of Optics* described the camera obscura and made him known as the field's "father."

ANSWER: Ibn **al-Haytham** (or **Alhazen**; accept **Alhazen's** problem)

(6) **This scientist names a theorem that can be derived using Mohr's theorem and that relates the bending moments at three adjacent supports on a horizontal beam. This scientist first stated a combination of several equations, including (+) Gay-Lussac's law, as the ideal gas law. This scientist is the second namesake of a relation used to calculate the slope of a coexistence curve on a (*) P-T diagram.** For the points, name this French scientist who names a relationship between temperature and pressure at a discontinuous phase transition with Rudolf Clausius.

ANSWER: Émile **Clapeyron** (or Benoit Paul Émile **Clapeyron**; accept **Clapeyron's** theorem, **Clapeyron's** theorem of three moments, **Clapeyron's** graph, or Clausius-**Clapeyron** relation)

(7) **These structures are connected to each other via pores of Kohn, and they are connected to larger vessels via the canals of Lambert. These structures contain epithelial cells called pneumocytes whose Type Two cuboidal subclass secretes a (+) phospholipid called DPPC to reduce surface tension and increase compliance. The permanent enlargement of these structures leads to (*) emphysema, which is a subtype of COPD.** For the points, name these tiny air sacs that facilitate gas exchange in the lungs.

ANSWER: **alveoli** (or **alveolus**; accept **air sacs** before mention; prompt on "lungs")

(8) **The reagent used in this test is also used in the Fontana-Masson stain to visualize melanin on histology slides. This test is generally applied after Brady's test is used to identify a functional group with a characteristic stretching frequency at (+) 1700 inverse centimeters in IR spec. This test uses a colorless solution of silver nitrate in aqueous ammonia, which reacts specifically with terminal (*) carbonyls to form a shiny precipitate.** For the points, name this chemical test that forms a characteristic silver mirror which is used to distinguish between aldehydes and ketones in a sample.

ANSWER: **Tollens' Test** (accept **Tollens' Reagent**; accept **silver mirror** test before mentioned)

(9) **In higher dimensions, this model shows phase transitions between ordered and disordered phases, as demonstrated by the Peierls argument. This model, which is generalized by the (+) Ashkin-Teller model, can be understood as an instance of Stanley's n-vector model when n is one. By working with transfer matrices, Lars Onsager was able to discover the solution for this model's (*) two-dimensional form.** For the points, name this model of ferromagnetism which has discrete variables representing magnetic dipole moments in the negative one and plus one states.

ANSWER: **Ising** model (or Lenz-**Ising** model)

(10) **An increase in either this quantity or age shifts a stellar isochrone to the right. Walter Baade used this quantity to classify stars into population One and Two types. This quantity can be measured for a star by taking common (+) logarithms of ratios of the number of iron atoms and the number of hydrogen atoms per unit volume. This quantity is measured using a unit called the dex and can be denoted as (*) Z.** Used in astronomy, for the points, name this measure of the amount of elements that are heavier than helium and hydrogen.

ANSWER: **metallicity** (accept **abundance** ratio; accept **iron-to-hydrogen** ratio or **Fe-to-H** ratio before "iron" is mentioned)

(11) **One member of this genus causes Pott's disease, which can lead to necrosis of spinal discs. The rapid identification of members of this genus can be performed using an interferon-gamma release assay or by staining with an (+) acid-fast stain named for Ziehl and Neelsen. One species in this genus targets macrophages in the alveoli, causing the formation of granulomas and a signature (*) bloody cough.** For the points, name this genus of bacteria whose members cause leprosy and tuberculosis.

ANSWER: **Mycobacteria** (or **Mycobacterium**)

(12) **Heterocyclic compounds can be created using a form of this reaction with inverse electron demand. Pyridines are formed by the aza- modification of this reaction that can form (+) "one, two" or "one, four" adducts. Overlap between the HOMO and LUMO favors a transition state with the "endo" conformation in this (*) four-plus-two cycloaddition reaction.** For the points, name this reaction which was discovered by two German chemists and creates a cyclohexene derivative through the reaction of a diene and a dienophile.

ANSWER: **Diels-Alder** reaction (accept intramolecular **Diels-Alder** cycloaddition;)

(13) **This phenomenon could be described by models that consider changes in the thickness of the crust or changes in rock density, which are the Airy-Heiskanen and Pratt-Hayford models. (+) Clarence Dutton coined the term for this phenomenon, which was used to explain how different parts of the Earth have different heights and is responsible for post-glacial rebound. Not applying to regions like the (*) Himalayas,** for the points, name this gravitational equilibrium between the crust and the asthenosphere, in which the crust is allowed to float.

ANSWER: **isostasy** (or **isostatic** equilibrium; accept **isostatic** rebound)

(14) **This process may have occurred during or after the reheating event, according to the Affleck-Dine mechanism. Electroweak symmetry breaking and (+) sphaleron transitions may have contributed to this process, which requires thermodynamic nonequilibrium and C and CP violation to occur according to two of the Sakharov conditions. (*)** For the points, name this hypothesized process that preceded nucleosynthesis which attempts to explain an asymmetry in which matter, rather than antimatter, is more prevalent in the universe.

ANSWER: **baryogenesis** (or **baryosynthesis**)

(15) **Advection cools some of these things called "Polish doughnuts." Fluid instabilities caused by a decrease in angular velocity in a magnetic field leads to these objects becoming turbulent in the Velikhov-Chandrasekhar, or (+) magneto-rotational, instability. Shakura and Sunyaev modeled these objects, whose spinning gives rise to the astrophysical jets emitted from (*) active galactic nuclei. For the points, name these circular structures made up of debris that accumulates around massive objects like black holes.**

ANSWER: **accretion disks** (prompt on "disks" or "astrophysical disks")

(16) **A gradient of these molecules is responsible for most tropisms in the Cholodny-Went model. The anionic [[an-"EYE"-on-ik]] form of this class of molecules can be transported across membranes via (+) PIN proteins in a form of "polar transport." Examples of these hormones include two-four-D, which is found in the herbicide Agent Orange, while their most common example is (*) indole-three-acetic acid. For the points, name this class of plant hormones which mediates cell elongation and apical dominance to help plants grow towards sunlight.**

ANSWER: **auxins** [{"OX"-ins}] (accept polar **auxin** transport)

(17) **In 1924, this scientist first conjectured the existence of tetraoxygen to explain why liquid oxygen violates Curie's law. The article "The Atom and the Molecule" describes a theory developed by this scientist, which is called the (+) cubical atom model. This scientist coined the term for photons and his theory of acid-base reactions models acids as (*) electron-pair acceptors. For the points, name this chemist who discovered the covalent bond and showed bonds between atoms in his namesake "dot structures."**

ANSWER: Gilbert **Lewis** (or Gilbert Newton **Lewis**; accept **Lewis** acids or **Lewis** bases or **Lewis** structures or **Lewis** dot formulas or **Lewis** dot structures or or **Lewis** electron dot structures)

(18) **The Ackermann function does not possess the "primitive" form of this concept, even though it is Turing-computable. Dynamic programming is an alternative to this (+) procedure and reduces time by caching already-determined values. This problem-solving approach, which is used in merge sort, requires the use of a (*) base case to prevent an infinite loop. Divide and conquer algorithms make use of, for the points, what computer science technique in which a function calls itself?**

ANSWER: **recursion** (or **recursive**)

(19) **One of these landforms containing the city of Almere is surrounded by a ring of "bordering lakes" that prevent groundwater in neighboring lands from seeping away. These regions, the (+) "Noordoost" example of which is used for agriculture, are often found in former marshes converted via pumping stations. To maintain the habitability of these low-lying artificial creations, (*) dikes are used to prevent flooding. For the points, name these flat regions of reclaimed land, exemplified by Dutch Flevoland.**

ANSWER: **polder** (prompt on "island" before "Noordoost;" prompt on "reclaimed land" before mentioned)

(20) **This scientist proposed studying the "hegemonic Zermelo-Fraenkel framework" in an essay that criticizes Derrida and other postmodernists. In a book co-written with Jean Bricmont called (+) Fashionable Nonsense, this physicist discusses his 1996 submission of an article titled "Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity," which was not subject to (*) peer review. For the points, what NYU physicist created a scandal when he published a fake article in the journal *Social Text*, prompting questions about intellectual rigor?**

ANSWER: Alan **Sokal** (accept **Sokal** Affair)

(21) **This scientist created the concept of a current algebra and proposed the idea of strangeness to explain kaon and hyperon decay. A set of independent three-by-three matrices spanning the (+) Lie [[LEE]] algebra are named for this scientist, and those matrices generalize Pauli matrices to SU(3) groups. In 1961, Yuval Ne'eman and this scientist proposed an (*) Eightfold Way to classify hadrons. For the points, identify this Nobel Prize-winning American scientist who coined the term "quark."**

ANSWER: Murray **Gell-Mann** (accept **Gell-Mann** Matrices)

(22) **Limits of these things are the subject of Doob's convergence theorems, which can be shown with an upcrossing inequality and a gambling argument. When these processes have bounded differences, they satisfy the Azuma-Hoeffding inequality, and stopped (+) Brownian motion is an example of these processes. Originally referring to a strategy in which a gambler repeatedly doubled their bet, (*) for the points, name these sequences of random variables which satisfy a rule such that the conditional expectation of the next value is equal to the current value.**

ANSWER: **martingales** (accept super-**martingale**; accept Doob's **martingale** convergence theorems)

(23) **Prior to this 1927 experiment, one of its namesakes worked on similar experiments with Charles H. Kunsman. This experiment, conducted at Western Electric, involved firing a beam of slow-moving electrons at a (+) nickel crystal target. The researchers observed that the scattered electrons showed a diffraction pattern, with peaks in intensity at specific angles. (*) For the points, name this doubly eponymous 1927 experiment that confirmed the de Broglie hypothesis and demonstrated the wave-particle duality of matter.**

ANSWER: **Davisson-Germer** experiment

(24) **The Lau event and the Mulde event were two of three minor extinctions that occurred during this period. Vascular plants emerged during a "Revolution" named for this and a later period, the (+) third and shortest period of the Paleozoic Era. This period saw the diversification of jawed fish as well as the terrestrialization of three different groups of (*) arthropods. For the points, name this geologic period of Earth's geological history which preceded the Devonian.**

ANSWER: **Silurian** Period

(25) **This institution is home to the world's most powerful internal confinement fusion device, which is found at its National Ignition Facility. This institution researches plutonium properties from a complex called the (+) SuperBlock. This institution created the warheads for the Polaris missile, and the element with atomic number 116 is named for this institution. (*)** For the points, name this research institution sponsored by the Department of Energy, which is based in California and was co-founded by Ernest Lawrence.

ANSWER: Lawrence **Livermore** National Laboratory (or **LLNL**; accept University of California Radiation Laboratory, **Livermore** Branch; accept **Lawrence Radiation Laboratory**; accept Lawrence **Livermore** Laboratory; accept **LLL**; accept **Livermorium**)

(26) **This species has two subspecies, one native to the continental mainland and the other native to Principe, and it is distinguished by red tail feathers contrasting with otherwise largely monotypic plumage. A specimen of this species known as Griffin is a research subject of MIT biologist Irene (+) Pepperberg, who named a different former research subject of this species after an acronym for "Avian Learning Experiment," or Alex. Adults of this species are thought to have the intelligence equivalent of a 4-6 year old human child, and it ranges from (*) Cote d'Ivoire to Ghana. For the points, name this species of parrot thought to be the most intelligent bird species.**

Answer: **Grey Parrot** (Accept **African Grey** Parrot; accept **Congo Grey** Parrot; "Parrot" not needed after mention)

(27) **This person names a type of condition allowing a partial differential equation to have a solution on the boundary. With Édouard Goursat [[gor-SAH]], this person names a theorem stating a value of zero for the contour integral of a (+) holomorphic function on a simply connected domain. This mathematician founded the field of complex analysis and formalized the concept of a (*) limit. For the points, name this Frenchman who, with Hermann Schwarz, names an inequality that generalizes the triangle inequality to inner products.**

ANSWER: Augustin-Louis **Cauchy** [[KOH-shee]] (accept **Cauchy** boundary condition or **Cauchy** integral theorem or **Cauchy**-Goursat theorem or **Cauchy**-Schwarz Inequality or **Cauchy**-Bunyakovsky-Schwarz inequality)

(28) **This adjective names a cooling technique in which liquid helium removes heat from a magnetocaloric substance in a magnetic field. An index described by this adjective and denoted gamma equals the ratio of (+) specific heats at constant pressure and constant volume. Two isothermal steps alternate with two steps that have this property in the Carnot cycle. The change in (*) internal energy equals the work done in systems with, for the points, what property which describes a process with zero net heat transfer?**

ANSWER: **adiabatic** (accept **adiabatic** index or **adiabatic** expansion or **adiabatic** compression, or **adiabatic** demagnetization)

(29) Rust is used to develop a backend for these programs called Cranelift. These programs can carry out a process following the switch to static single assignment form in which static values are computed during sparse conditional (+) constant propagation. These programs are typically designed with a middle end, which applies optimizations like dead-code elimination, while the front end does type checking, lexing, and (*) parsing. For the points, name these programs which translate high-level programming languages to low-level assembly languages.

ANSWER: compilers

(30) The length of one of these constructs is related to the lengths of all the sides of a shape in Apollonius's theorem, which is an instance of Stewart's theorem. In a triangle, three of these (+) line segments intersect at a point that divides them into smaller segments with lengths in a two to one ratio. Each of these line segments that intersect at the (*) centroid, and each of them divides the area of a triangle in half. For the points, name these line segments in triangles, which link the midpoint of a side with the vertex opposite that side.

ANSWER: medians

(31) Receptors for acetylcholine and this molecule are antagonized by the neurotoxin strychnine. Though it and proline are rarely found in alpha helices, this molecule makes up one-third of the triple-helix structure of (+) collagen. This molecule and GABA are the two most common inhibitory neurotransmitters in the central nervous system. This is the only (*) achiral [[ay-KY-ral]] proteinogenic amino acid, with a single hydrogen atom as its side chain. For the points, identify this simplest stable amino acid.

ANSWER: glycine (or Gly; prompt on "G")

(32) In oxides, this quantity is found to be dependent on its value at absolute zero and an exponential term, per Wachtman's formula. In the linear elastic region, this quantity can be computed as (+) tensile stress divided by axial strain. For homogeneous isotropic objects, this quantity can be computed as "the bulk modulus times the quantity three minus six times (*) Poisson's ratio." For the points, name this quantity which measures the stiffness when a force is applied along the length of a material and determines how easy it is to bend.

ANSWER: Young's modulus (accept elastic modulus or modulus of elasticity)

(33) Embedding code from this language in another program is made possible via the Call Level Interface, and precompiling code from this language is done via parametrized statements. This language's syntax allows programmers to use (+) "group by" and "order by" clauses, while the "from" clause specifies the table from which data will be inspected. This language was developed by Donald Chamberlin and Raymond Boyce and contains keywords like (*) "select." For the points, name this language, which is used to manage data in a relational database management system.

ANSWER: SQL [["sequel"]] (or Structured Query Language)

(34) Data from the citizen science app SnailSnap has shown that this effect has likely caused snail shells to evolve to be more yellow. Efforts to mitigate this phenomenon include ground-based (+) albedo modifications such as lighter-colored roofing and increased green spaces. The use of asphalt in pavement contributes to this phenomenon in (*) Phoenix, Arizona. For the points, name this phenomenon where city centers are significantly warmer than surrounding, less developed areas.

ANSWER: urban heat island effect (or UHI; prompt on "climate change" or "global warming")

(35) The Bartonian stage of this epoch was when a "middle climatic optimum" occurred. During this epoch, a "greenhouse Earth" may have been reversed by the Azolla event during which (+) ferns may have formed blooms in the Arctic Ocean. The Popigai impact structure might be linked to the Grande Coupure extinction that occurred between this epoch and the Oligocene. (*) For the points, name this second epoch of the Paleogene period, whose name references the "new dawn" of many animals.

ANSWER: Eocene [[EE-oh-seen]] epoch (accept Eocene-Oligocene extinction event, Eocene-Oligocene transition, Middle Eocene Climatic Optimum, or Middle Eocene Thermal Maximum)

Extra Questions

(1) This structure was encased in a cube-shaped balloon, and it used "Spedding's eggs," which were uranium cylinders that were placed in graphite holes. Arthur Compton declared (+) "The Italian navigator has landed in the New World" on the success of this structure, which was moved to Site A from its original location at Stagg Field. Created in 1942 by a team led by (*) Enrico Fermi, for the points, name this first artificial nuclear reactor, which was built in Illinois.

ANSWER: Chicago Pile-One (or CP-One)

(2) The natural logarithm of the ratio of the initial and final values of this quantity appears in the ideal rocket equation. The standard gravitational parameter is equal to the product of this quantity and a constant symbolized with the (+) capital letter G. Two values of this quantity are multiplied together with the gravitational constant, then divided by the square of the distance, in (*) Newton's law of universal gravitation. For the points, name this quantity which is multiplied by acceleration and found to be equal to net force in Newton's second law of motion.

ANSWER: mass

(3) Solutions to this type of equation are the x-coordinates where the Carlyle circle intersects the x-axis, and the sums and products for solutions to this type of equation are equal to "minus b over a" and "c over a," per (+) Vieta's formulas. This type of equation can be solved using a formula in which the plus-minus symbol appears in the numerator between the (*) discriminant and "minus b," while the denominator is "two times a." For the points, name this type of equation which can be written as "a times x squared plus b times x plus c equals zero."

ANSWER: quadratic equation (accept degree two or order two or second order)

(4) **This company offers a security software suite called Symantec Endpoint Protection. This company, which acquired the cloud computing company VMware in 2022, co-developed the (+) Tensor Processing Unit with Google. This company remains the most recent to have reached a market capitalization of one trillion dollars. (*)** For the points, name this fabless manufacturer, which holds the second-largest market valuation among American software and semiconductor companies, behind Nvidia.

ANSWER: **Broadcom** Inc.