

2020 National Science Bee – Varsity and Junior Varsity

Round 1

1. In the paper "Deterministic Nonperiodic Flow," the author expressed doubts that this task needed to be done quickly due to a non-uniform, stable, nonperiodic, noncentral trajectory by convection flows. Edward Lorenz's work on numerical methods to perform this task using pressure, wind speed and other metrics led him to determine that the phenomena involved in this task are non-linear. Due to the atmosphere behaving as a chaotic system, this task is often only accurate for up to two weeks at most. Air precipitation, temperature and cloud movement can help with this task. For the point, name this task of determining atmospheric conditions.

ANSWER: **forecasting** the weather [accept **weather prediction**; or **predicting** the **weather**]

ACCEPT: logical equivalence like "**inferring weather** patterns"; or "**meteorology**"

REJECT: more specific weather-related phenomena prediction such as "Tornado predicting" or "Temperature prediction"

2. The chloralkali process produces a sodium type of this mixture as a byproduct, which is continuously drawn out of the cell to be neutralized with water. This sort of mixture is the active ingredient in a Jones reductor. Hydrochloric acid and one of these mixtures with Zinc are used to reduce ketones in a Clemmensen reduction. In dentistry, these mixtures with around 25% silver and 10% copper are controversially used for some fillings. The protective layer of aluminum oxide is quickly corroded by mercury forming one of these mixtures. For the point, name these mixtures, the uniting of mercury and another metal.

ANSWER: **amalgams** [prompt on mercury mixtures or mercury solution and similar]

3. This language has database manipulation packages like pandas and an integrated development environment IDLE for writing source code. This duck-typed language was used to write the web building framework Django. This interpreter language, which is now on version 3.7, still provides some backwards compatibility for version 2.7 which was sunsetted in 2020. This language was created by Guido van Rossum in 1991 and provides ample readability by requiring tabs to delimit bodies. For the point, name this programming language named for a comedy sketch crew and not after a snake.

ANSWER: **Python**

4. A cold spot in this feature related to the constellation Eridanus is thought to be explainable by the existence of a supervoid. A shotgun was used to kill pigeons roosting in a horn antenna in an unfortunate casualty that helped confirm the discovery of this feature. The superclusters and voids that permeate this phenomenon were elucidated by Martin Rees and Dennis Sciama, giving an explanation for how photons are affected by this phenomenon in the Sachs-Wolfe effect. The polarization patterns of this phenomenon can be divided into E and B modes, and satellite missions to collect data from this phenomenon include COBE, WMAP and Planck. Bell Labs astronomers Robert Penzias and Arno Wilson won the 1978 Nobel Prize in Physics for the discovery of this "radiation noise." For the point, name this radiation that permeates the universe whose wavelength is the same radiation range as that used to quickly reheat food.

ANSWER: **Cosmic Microwave Background Radiation** [or simply **CMBR**]

AFTER "radiation (noise)" IS READ ACCEPT: **Cosmic Microwave Background** [or **CMB**]

5. Using a decomposition technique with this prefix helps find two mathematical structures with this word in their name, which is made easier by transforming the problem via the Lanczos algorithm. A spectrum of an operator contains scalars of this prefix by the Spectral theory. Roots of the characteristic polynomial of a matrix have this prefix. Both x in the equation $Ax = \lambda x$ and the scalars it contains are prefixed by this word for a given matrix A . This prefix comes from the German for "characteristic" and λ is used in Linear Algebra to represent scalars with this prefix. For the point, name this prefix of certain values and vectors of matrices.
ANSWER: **eigen** [accept **eigenvectors**; accept **eigenvalues**]

6. While many animals and fungi possess some MADS-box genes, the number is significantly greater in plants that participate in this process. AGAMOUS is a mutant in a long-day model organism used to study this process. Cadherin genes play a role in dividing out three regions where type A and C genes are mutually antagonistic in the ABC Model of this process. This process results in the formation of perianth, pistils and stamens. For the point, name this characteristic angiosperm-related process during which a reproductive organ with petals is formed by plants like roses and tulips.
ANSWER: **budding** [accept **flower development**; accept **blossoming**; accept **blooming** (until mentioned)]

7. The controversial compound Thimerosal is used as a preservative for some of these preparations. Aluminum hydroxide is an adjuvant used in some of these preparations which come in attenuated and inactivated varieties. Andrew Wakefield lost his practising licence for continuously claiming that the MMR one of these preparations could be linked to autism. For the point, name these injections designed to emulate pathogens and strengthen the immune system to prevent infection, which succeeded in eradicating smallpox.
ANSWER: **vaccines**

8. John B. Goodenough, Stanley Whittingham, and Akira Yoshino were honored with the 2019 Nobel Prize in Chemistry for work done on the advancement of these devices. In this specific device, an electrolyte serves as a guard separating a certain positive ion and trapping it in graphite while electrons are able to flow back through a circuit. A separator helps prevent explosions in these devices which can sometimes happen when mistakes in the manufacturing process occur causing the cathode and anode to touch, as happened with some Samsung Galaxy Note 7s. For the point, name this rechargeable battery that makes use of the lightest alkali metal.
ANSWER: **lithium** ion **battery** [prompt on reusable / rechargeable **battery**; after "battery" accept **lithium** ion]

9. The binary interactions of these events lead to a decrease in distance of their low-pressure areas in an effect named for Fujiwhara. The curving of clouds around these events leads to a so-called stadium effect. They're not thunderstorms, but the ascending motion of Madden-Julian oscillations is associated with these events. The Northwestern Pacific Ocean is an active basin for these events year round. Hurricane John became one of these things in 1994 once it crossed the International Date Line. For the point, name these violent weather storms that affect Taiwan, Japan, the Philippines, and China.
ANSWER: **typhoons** [prompt on **cyclone** or **tropical cyclones**; accept Hurricane until the syllable "west" in "Northwestern" in line 4 is read.]

10. This scientist won the Nobel Prize in Physiology or Medicine in 1953 for his work on discovering a set of biochemical reactions alongside Fritz Lipmann, who received the prize for his related work on Coenzyme A. This scientist and his student Kurt Henseleit give an alternative name to the Urea cycle. This scientist gives the alternative name to a cycle that begins with the addition of pyruvate to oxaloacetate and occurs in the matrix of mitochondria as a precursor to oxidative phosphorylation. For the point, name this German-born British biologist who gives an alternate name to the Citric Acid cycle.

ANSWER: Hans Adolf **Krebs**

11. Borohydrides are modelled using the 3c-2e variant of this structure. A variety of these interactions cannot occur at bridgeheads according to Bredt's rule. Lewis acids are responsible for the dative type of this interaction. The inductive effect occurs through these interactions. The bent variety of these interactions cause high ring strain, occur in molecules like cyclopropane, and are alternatively named for resembling bananas. These types of structures form when electrons are shared between two atoms or when one atom rips the electron off another. For the point, name this structure formed between two atoms which include covalent and ionic variants.

ANSWER: **bonds** [accept covalent **bonds**; accept double **bonds**]

12. The University of Liverpool promoted the use of a "snout-nosed pig" adapter that has three rotatable receiver flasks attached to Perkin's triangle for the vacuum form of this process. It's not related to chromatography, but one of the most common uses of calculating theoretical plates is for this process to increase its efficiency. A solution of 96% water and 4% ethanol forms when performing this process on ethanol, which cannot be extracted further as the solution is azeotropic. For the point, name this process of separating two liquids by raising temperature to a boiling point.

ANSWER: **distillation**

13. PRDM16 is a transcription coregulator that controls development into a cell of this type. In this type of cell, apelin produces a positive feedback loop to increase insulin production. These cells are separated into three tissue types: WAT, MAT, and BAT. The large amount of mitochondria in one type of these cells give them a brown color and assist in thermogenesis. Enterocytes and these cells secrete leptin to help suppress the hunger response which regulates their size and storage. For the point, name these cells that specialize in storing lipid fat droplets.

ANSWER: **adipocytes** [accept **adipose** tissue; prompt on fat cells or fat tissues]

14. The weighting of these constructs is measured by the Roman domination number. Proving a clique of size n exists on one of these structures is an NP-complete problem. A widely studied counterexample to many problems in the theory that studies these constructs was given by Julius Petersen; that example of one of these constructs has a Hamilton path, but no Hamilton cycle, a crucial requirement of the travelling salesman problem. Euler helped establish the theory of these constructs by proving that the seven bridges of Königsberg could be reduced to a problem on one of these constructs. For the point, name these constructs with vertices whose relation is shown through connected edges.

ANSWER: **graphs**

Description Acceptable

15. The principle offense that triggered this event came from a text whose two main logical interlocutors Salviati and Sagredo are at argument with a consistently refuted Aristotelian named Simplicio. This event's target had earlier talked to a former student Benedetto Castelli about the role of theology in his scientific discoveries which culminated in him writing a letter to the Grand Duchess Christina. Shortly after this event, its target apocryphally said "Eppur si muove" or "and yet it moves" in defense of writing the *Dialogue Concerning Two Chief World Systems*. For the point, name this event where the discoverer of four moons of Jupiter was found guilty of heresy for defending heliocentrism and placed under house arrest until his death.

ANSWER: **trial** of **galileo** [accept reasonable equivalent answers indicating **Galileo**]

16. John Ioannidis noticed a quote-unquote "Prometheus phenomenon" where even if experiments have this property, the significance of the results decreases in further experimentation. If an experiment has this property, repeated measurements of some measurand under identical conditions yields measurements that closely agree. Psychological experiments often fail to have this property, likely because further trials of the same psychological experiment cannot often be assumed to be parallel on the same subjects. For the point, name this property of an experiment where performing the experiment again achieves similar results.

ANSWER: **reproducibility** [accept word forms like **reproducible** or **reproduction**; accept **repeatability** and word forms like **repeatable**; accept **verifiable** or word forms like **verifiability**]

17. In their BRIDGE study, Jules Angst and colleagues identified that 47 percent of patients with MDD met the specifier criteria for this disease. The highest risk of cyclothymia is from the type 1 form of this disorder. Opposite pole symptoms commingle in the "mixed state" specifier for this disease. Rapid cycling is a severe form of this disease characterized by four or more mood episodes in a year. Lithium is commonly used to treat this psychiatric disorder that can cause symptoms of euphoria for periods followed by periods of dysphoria. For the point, name this disease characterized by bouts of mania and depression.

ANSWER: **bipolar** disorder [accept **manic-depressive** disorder or **manic depression**]

18. Local operations and classical communication can be used to transform states exhibiting this phenomenon. The states exhibiting this phenomenon give rise to Bell pairs. This phenomenon is the subject of a debate where two particles with unstable spins head in opposite directions. The EPR paradox brought up that potential violation due to this phenomenon. Einstein criticized this phenomenon with that paradox calling it "spooky action at a distance." For the point, name this quantum phenomenon where two quantum states are bundled into one.

ANSWER: **entanglement** [accept answers like **entangled** states]

19. The linearization of these equations can be done by taking its Jacobian at an equilibrium point which is referred to as the community matrix. The name for these equations is shared with a competitive form that instead uses a logistic equation basis. These equations typically take the following form: Equation 1 (*read slowly*) $dx-dt$ equals αx minus β times x times y . Equation 2 (*read slowly*) $dy-dt$ = δx times y minus γ times y . Those two equations encode the self interaction of the species and its interaction with its counter-role species. For the point, name these doubly eponymous equations important to mathematical biology that model predator-prey relations.

ANSWER **Lotka-Volterra** equations [accept Competitive **Lotka-Volterra**; prompt on partial answers; prompt on predator-prey equations]

20. Vaska's complex has this geometry as does another iridium catalyst which is an air-stable orange solid homogeneous catalyst used for hydrogenation reactions. Crabtree's catalyst has this geometry which is the theorized geometry of d8 metal complexes. Alfred Werner used the cis- and trans- isomers of cisplatin to determine it had this geometry. In the AXE method of determining molecular geometry, this geometry corresponds to X equals 4 and E equals 2. For the point, name this flat geometry where the central atom has four bonds to its four corners at approximately 90 degrees.

ANSWER: **square planar** [prompt on planar]

21. Tibor Rado formulated a concept involving these structures where they march through and mark ones on a tape, trying to obtain the maximum number of ones. These structures' substructure includes a transition function, an instruction table, and an infinite tape written and read by a head pointer. These constructs are the subject of the Busy Beaver Game. An effective method exists for a function over the natural numbers if it is computed by one of these machines according to Alonzo Church. These models are the subject of the halting problem. For the point, name this general-purpose computer model, a so-called machine named for a British computer scientist.

ANSWER: **Turing Machine** [accept **TM**]

22. The lack of terrestrial or aquatic fossils spanning the beginning of this period followed by the transition from placoderms to ray-finned fish is known as Romer's Gap. During this period, predatory predecessors to the modern-day dragonfly with a 2 foot wingspan were thriving. Tree fern based ecosystems dominated following the Rainforest collapse of this period which divided into the Mississippian and Pennsylvanian periods. For the point, name this geological period that followed the Devonian period, during which global formation of coal beds occurred.

ANSWER: **carboniferous** period

23. This theory is generated by the direct product of SU(3), SU(2), and U(1). Events that helped bolster this theory and carry out its predictions include the OPAL experiment at LEP, alongside ALEPH, DELPHI and L3. Those experiments of this theory took place under the European Organization for Nuclear Research. Limitations to this theory include the inability to account for neutrino oscillators or baryon asymmetry. This theory overarches quantum chromodynamics, and was bolstered by the finding of the Higgs boson in 2012. For the point, name this physics "model" that encodes three of the four fundamental forces of physics while classifying the known elementary particles.

ANSWER: **standard model** [accept standard after "model"]

24. To measure the stiffness of compounds of this type, Hans Kuhn developed a namesake length. An equation modelling the formation of this type of compound sets $X_{\text{bar sub n}}$ equal to one divided by quantity one minus the extent of reaction. The production of this type of compound can be modelled by Carothers equation and can be sped up by use of a Ziegler-Natta catalyst. This type of compound is formed by step-growth or a chain-growth mechanism. For the point, name these compounds made up of chains of monomers.

ANSWER: **polymers**

25. David Kirzhnits worked with one of the discoverers of this process on its predecessor which proposed "cosmological phase transitions." This process underwent damped oscillations which decayed into radiation equilibrating to the reheat temperature. Alan Guth and Andrei Linde proposed this process as an explanation to the horizon and flatness problems, describing it as a sort-of gravitational repulsion. This process started occurring about 10 to the negative 36 seconds *after* the principal event that started the universe. For the point, name this process of rapid expansion that occurred shortly after the Big Bang.

ANSWER: Cosmic **Inflation**

26. In this scientist's namesake problem, the Laplace-Runge-Lenz vector is conserved. In an equation named for this scientist, the mean anomaly equals the eccentric anomaly minus eccentricity times the sine of the eccentric anomaly. Under this scientist's namesake orbit, astronomical bodies follow the vis-viva equation. This lab assistant of Tycho Brahe used Brahe's data to determine that ellipses more closely matched a heliocentric model of the planets. For the point, name this German astronomer who formulated three laws of planetary motion.

ANSWER: Johannes **Kepler**

27. Cases of a disease associated with this process began to occur in response to the vaccine Pandemrix. Kleine-Levin syndrome is characterized by chronic occurrences of this process. It's not appetite-related, but the hormone orexin or hypocretin has been linked to breaking this process. The suprachiasmatic nucleus over the optic chiasm tract breaks this process in response to sunlight, which is brought on in part by the hormone melatonin. Apnea can obstruct and rapid eye movement can occur during this circadian-rhythm regulated process. For the point, name this biological process fundamental to most animals during which dreams occur.

ANSWER: **sleeping** [or **somnolence**; accept answers indicating **sleep** such as falling **asleep**; prompt on answers like lethargy or drowsiness and similar answers]

28. Henry Fox Talbot's Calotype was a version of this process that made use of gallic acid. Thomas Wedgwood was an early pioneer in this process whose work does not survive due to not having a fixing agent to add to the silver nitrate. Charge coupled devices are commonly used in astronomy for this process because of their high quantum efficiency and taking advantage of auto-guiding as well as dark frame subtraction to create a less noisy result. An early form of this process worked by taking advantage of how light oxidises silver grains and used sheets of metal copper coated with silver iodide and is known today as the Daguerreotype. For the point, name this technique of creating images from captured film.

ANSWER: **photography** [accept equivalents like taking **photos**]

29. A displacement field related to this vector quantity is equal to the polarization plus this vector quantity times a constant. The curl of this vector field is equal to the negative partial derivative of the curl of magnetic vector potential. Gauss's law sets the divergence of this vector field equal to charge density over permittivity. In Lorentz's force law, this field is multiplied by charge, as its strength at any point is calculated as force divided by charge. For the point, name this field that influences the movement of charges, contrasted with the magnetic field.

ANSWER: **Electric** field [or **E-field**]

30. This circuit device is often simplified as a switch that turns on above a threshold voltage. For the discovery of how semiconductors could be used to create these devices, Brattain, Bardeen and Shockley were rewarded the 1956 Nobel Prize in Physics. This device is similar to a diode but has three layers either as NPN or PNP. The two main flavors of these devices are Bipolar Junction and Field Effect. Integrated circuits doubled the amount of these elements every year according to Moore's law prediction. For the point, name these elements named for behaving like a resistor that can transfer electrical signals.

ANSWER: **transistors** [accept MOS **transistor**; accept MOSFET **transistor**; accept (Metal-Oxide Semiconductor) Field Effect **transistor**; accept Bipolar Junction **transistor**]

Extra Tossups

31. The functional units of this organ can communicate by Pores of Kohn, which mature at the age of 4 around the same side of this organ's canals of Lambert. Angiotensin converting enzymes not produced by vascular endothelium are predominantly found in the circulation of these organs. DPPC is a major component of the surfactant produced by these organs to maintain surface tension with the atmosphere. Gas exchange occurs in the alveoli of these organs, which are divided into five distinct lobes and inflate through contraction of the diaphragm. For the point, name these organs responsible for oxygen uptake from the air.

ANSWER: **lungs**

32. Roger Apery proved the sum of $1/n^3$ from 1 to infinity has this property, equivalent to the Riemann Zeta function of 3. Thomae's function is continuous for this type of number which it outputs zero for. The continued fraction representation of these numbers are non-terminating. Legendarily, Hippasus was drowned for telling followers of Pythagoras that a number of this type existed. This type of number cannot be represented as a fraction with an integer in both the numerator and denominator. For the point, name this subset of the real numbers whose decimal form is non-terminating, such as pi and radical 2.

ANSWER: **irrational**