2020 National Science Bee – Varsity and Junior Varsity Round 3

Regulation Questions

1. Graal is a JIT compiler written in this language, designed to support files written in a mix of languages. This language, C sharp, and Kotlin are the top three used in the Android Software Developer Kit. The default graphics library for this language is Swing. This language was developed at Sun Microsystems by James Gosling. The virtual machine used to run the bytecode compiled from this language has led to advertisements of this language with the slogan "write once, run anywhere." For the point, name this object-oriented programming language, not to be confused with a similarly named "script" whose logo is a coffee mug in reference to an Indonesian island.
ANSWER: **Java**

2. Experimentation with this color was important to a Nobel Prize in Chemistry won by Martin Chalfie, Osamu Shimomura, and Roger Tsien. Vervet monkeys and other members of the Chlorocebus genus are sometimes erroneously referred to as the African [this color] monkey. A protein from Aequorea victoria, a bioluminescent jellyfish has this color in its name because it emits a wavelength in the 500 range after being excited with blue light. A molecule with a porphyrin ring and a central magnesium ion is found in thylakoids and is responsible for giving off this pigment for organisms that undergo photosynthesis. For the point, name this color reflected by chlorophyll responsible for giving leaves and grass their characteristic hue.
ANSWER: **green**

3. The symbol representing this operation appears next to the right side vector in a material derivative. Lagrangian multipliers are derived by setting this operation on a function equal to lambda times this operator on a constraint function. The nabla symbol is used to define this operation which when squared represents the Laplacian. Divergence is a dot product of a vector with this operator while the curl is the cross product of a vector with this operator. For the point, name this mathematical operator which encodes the partial derivatives with respect to each dimension at a point and is symbolized by Del, an upside down triangle.
ANSWER: **gradient** operator (or vector field) [accept **gradient** descent; prompt on Del; prompt on Nabla]

4. This is the more massive of two types of objectives cooled via the Urca process. Degenerate matter within the crust of these objects is thought to exist in gnocchi, spaghetti, lasagna and other "pasta" phases. A rotating form of these objects can cause radio frequency signals which gave the first of them names starting with LGM for "little green men." Those rotating variants of these objects were found by Anthony Hewish and Jocelyn Bell. The upper bound on this type of star is given by the TOV limit and like smaller white dwarves they are held up by degeneracy pressure. For the point, name this type of superdense star made up of a namesake uncharged subatomic particle.
ANSWER: **neutron** stars [accept **pulsar**s]

5. When the absolute value is taken of the regularization term in the Ridge method of this class of techniques, the method is referred to as Lasso. When the dependent variable is binary, such that the prediction is either true or false, the logistic method in this form of analysis is used. The standard approach in this form of analysis finds two beta parameters of a linear function by finding the minimum of the sum of residuals in the method of least squares. The linear variant fits a line to a set of data points whose accuracy can be determined via an r squared measure. For the point, name this form of analysis which estimates the relationship between a dependent and one or more independent variables.
ANSWER: **regression** analysis

6. Superconductors undergo a form of particle scattering at the boundary between the superconductor and another conducting material, which is described as a form of this process named for Andreev. Lambert's cosine formula is used to model a diffuse form of this process. This process does not occur at Brewster's angle, and the albedo characterizes this process for gray bodies. Beyond the critical angle, the total internal form of this process occurs in waveguides like fiber optic cables, and the angles of the outgoing and incident rays with respect to the normal are equal in this process. For the point, name this process in which waves bounce off a surface like light off a mirror.
ANSWER: **reflection**

7. Two topological parameters L and S are among the six factors used to predict loss of one resource due to this process in the USLE. For that resource, this process typically advances through less severe forms like splash and sheet into more severe forms like rill and gully. The three forms of movement — suspension, saltation, and creep -- can occur when wind facilitates this process. Glaciers undergo this process via abrasion or plucking. Surface runoff or rainfall moving soil is an example of this process. For the point, name this process of transporting soil rock or material from one location and displacing it to another, contrasted with stationary weathering.
ANSWER: **erosion** [accept soil **erosion**]

8. A low power variant of the in-development DDR5 implementation of this resource was released in February 2019. The kernel can make use of zones to manage this resource alongside algorithms like the buddy system to prevent its external or internal fragmentation. This resource, which can be volatile or non-volatile, is managed by programs in C with the functions free and malloc. The stack and heap are two fragments of this resource used by computer programs. This resource is physically implemented on computers using RAM and ROM. For the point, name this portion of the computer where information is stored for later use.
ANSWER: **memòry**

9. According to C.J. Adkins, the thermal category of this concept has two bodies with no net heat flow while reaching the thermodynamic category requires exchange of work. In chemistry, the constant of this concept is the ratio of a reaction's forward and reverse rate and is typically symbolized k. This state can generally be pushed to the right or left by following Le Chatelier's principle. For the point, name this concept of some variable achieving a balanced or steady state, which can be visualized as a balanced seesaw.
ANSWER: **equilibrium**

10. Hirsch names a taller variant to one named variant of this lab equipment with a smaller fritted plate. A stopcock is used to control the rate at which they function in the dropping variety of this lab equipment. The separatory variety of this lab equipment is used in liquid-liquid extraction. The Buchner variety allows for fast filtration with this piece of lab equipment. This simple piece of plastic, glass, or stainless steel lab equipment in wider scale operations typically has a channel that of liquid that feeds into the wide end with filter paper placed near the narrow end. For the point, name this device which can aid in guiding liquid into a narrow opening of a container.
ANSWER: **funnel**

11. As t goes to infinity, the t-distribution approaches this function whose cumulative distribution function is equal to one half times the quantity one plus an error function term. With a large enough sample size the mean and variance of a population can be estimated by this distribution due to the central limit theorem. This distribution's first standard deviation covers 68 percent of the data and two standard deviations covers 95 percent. For the point, name this bell-curve shaped distribution sometimes named for a German mathematician.
ANSWER: standard **normal** distribution [or **Gaussian** distribution]

Specific Term Required.
12. Animals that readily opt into autotomy typically have this ability. A "guided" form of inducing this ability through barrier membranes has effectively worked on bone. Planarian flatworms and age-resistant hydras are model organisms studied for a highly efficient use of this ability which is also documented on a tissue-level in echinoderms like starfish and sea cucumbers. The prototypical example of this ability is the salamander's tail and typically for healing in humans, it results in scar tissue. For the point, name this process where an organism regrows and restores missing components, cells, or tissue
ANSWER: **regeneration** [accept word forms such as **regenerative** abilities; prompt on regrow or wound healing similar synonyms with "We need the specific term."]

13. These systems follow a second order, linear differential equation of the form -k over m times x [[pause]] equals the second derivative of x with respect to t. That formula has the solution x equals A times sine of quantity 2 pi f t plus phi, which can be used to obtain frequency as one over 2 pi times the square root of quantity k over m. That second order linear differential equation of these systems is obtained by substituting net force in Newton's second law with Hooke's law. For the point, name this periodic system that follows a namesake motion, commonly used to model springs.
ANSWER: Simple **Harmonic Oscillator** [or S**HO**; accept Quantum **Harmonic Oscillator** prompt on oscillator**]**

14. For a single charge, this equation can be derived by balancing diffusion due to Fick's Law and electromagnetic forces. Depending on whether the units are in moles or molecules, this equation can have a K over little q term or a R over F term multiplied by a T over Z term. This equation multiplies that whole term by the natural log of the ratio of concentration of the given ionic species on either side of a permeable barrier, such as a salt bridge or cell membrane to yield the namesake potential. For the point, identify this German-named equation which determines reduction potentials of electrochemical reactions.
ANSWER: **Nernst** equation

15. The primary signal of these events cannot be detected between 104 and 140 degrees due to refraction, a region referred to as the "shadow zone." The Flinn-Engdahl regions are helpful for identifying the starting location of these events. These events can be regularly caused by movement along Benioff zones. Harry Fielding Reid proposed that these events were caused by stored strain being released in an elastic rebound. They can occur frequently at strike-slip or dip-slip boundaries. During these events, longitudinal P waves are followed by slower transversal S waves. These events are measured on the Richter scale. For the point, name these catastrophic events studied by seismologists.
ANSWER: **earthquake**s

16. This data structure is navigated via dead-reckoning which allows for constant time lookup. When using multiple dimensions, this data structure can be organized as major row order or major column order. Matlab indexes this data structure starting at one, but most languages index them from zero. In Java, this data structure can be declared by first declaring the type and following the variable name with square brackets. This data structure is similar to a vector, but with fixed size in a contiguous block of memory. For the point, name this simplest data structure that allows for the storage of multiple values into a single variable.
ANSWER: **array**s

17. A variant of this organism known as TgPVR is studied for its ability to be infected by the poliovirus. Using pneumococcus strains, Frederick Griffith showed that transformation could occur by injecting type III-S virulent strains and type II-R strains into these animals. Mario R. Capecchi, Martin Evans, and Oliver Smithies won the 2007 Nobel Prize in Physiology or Medicine for developing a way to "knock-out" genes in this animal. The Ob/ob variety of this animal is prone to obesity, and a common species of this animal is *Mus Musculus*. For the point, name this most commonly used rodent in lab experiments, sometimes confused with rats.
ANSWER: laboratory **mice** or **mouse** [UNTIL MENTIONED: accept ***Mus Musculus***; prompt on *Musculus*]

18. Polyamides are the basis for a wearable form of this material developed by Wallace Carothers. In the United States, the type of this material can be identified by a resin identification number between one and seven. Leo Baekeland coined the term for this material and invented the first fully synthetic example of one, bakelite. Because it is likely an endocrine disruptor, the use of BPA as an additive to this material has been called into question. Examples of this material include polypropylene and polystyrene. For the point, name these highly malleable synthetic polymers which make up water bottles and milk jugs.
ANSWER: **plastic**s [prompt on polymers**]**

19. One competitor to this theory developed by Mordehai Milgrom is being called into question by data from DF2; that theory is called MOND. This theory allows for a metric solution that satisfies field equations involving the Ricci tensor and the Stress-energy tensor. Key evidence for this theory comes from LIGO's detection of gravitational waves and measurements of the precession of Mercury's perihelion. This theory derived from the equivalence principle describes the weakest fundamental force as curvature in spacetime. For the point, name this theory developed by Albert Einstein to explain the force of gravity, developed after his earlier theory of the speed of light.
ANSWER: theory of **general relativity** [accept **GR**; prompt on relativity]

20. In 1933 and 1934, this substance was the basis for over 20 papers Gilbert Lewis published on its isolation and use in synthesis. Harold C. Urey won the 1934 Nobel Prize in Chemistry for his discovery of this substance through the distillation of liquid hydrogen. This substance's breakeven point with Helium-3 makes Helium-3 a reactant with one of the highest energy yield rates. Graphite, light water, and this isotope's oxide are used as moderators to mitigate the velocity of fast neutrons in uranium nuclear reactors. This is the lightest non-exotic isotope. Heavy water consists of two instances of this isotope connected to oxygen. For the point, name this non tritium isotope of hydrogen with two neutrons.
ANSWER: **deuterium** [accept **D2**; accept **deuterium gas**; accept **deuterium** oxide]

21. Francesco Redi used non-liquid samples and sealed jars to perform an experiment similar to Needham's, which when done properly, resulted in rejection of this hypothesis. Attempts to revise this hypothesis after an 1859 experiment include classifying different processes under which it can occur such as heterogenesis and archebiosis. An experiment involving broth placed in a swan-necked glass was developed and carried out in 1859 by Louis Pasteur resulted in this hypothesis being disfavored in place of the idea of biogenesis. For the point, name this debunked process by which life is formed, thought to be evidenced by maggots growing out of seemingly nowhere on rotten meat.
ANSWER: **spontaneous generation**

22. Henry Bence Jones first made note of the hyaline cast most-commonly formed by the most abundant protein found in this liquid, a glycoprotein known as Tamm-Horsfall protein. Carbamide, a carbonyl connected to two oxidation-state neutral nitrogens, has another name that references this liquid. Henning Brand discovered phosphorus by preparing aliquots of this liquid. Micturition is another term to refer to the removal of this liquid from the body. Diuretics can speed up that process by which this liquid is removed. For the point, name this liquid produced in the kidneys and excreted from the body from a namesake tract after leaving the bladder.
ANSWER: **urine** [accept micturition before mentioned]

23. This protocol's fourth iteration adapted from Thunderbolt 3 was released in August 2019 and supports 40 Gigabits per second of throughput. This protocol uses four pins, two pins for positive and negative voltage leads and two for positive and negative data transfer. This protocol is the most widely used to hotplug devices. Standard formats for connector plugs used in this protocol include type B, type C and micro. For the point, name this common standard for connecting flash drives, keyboards, mice, and other devices, which sometimes requires flipping the connector plug to fit it into the socket.
ANSWER: **USB** [accept **universal serial bus**]

24. The difference in velocity applied by these devices enables a Hohmann transfer. A 50/50 mix of UDMH and NTO is a common hypergolic for these devices. The equation delta-v equals effective exhaust velocity over natural logarithm of initial total mass over final total mass was developed from Newton's second law for these devices by Soviet engineer Konstantin Tsiolkovsky. Oxidizers on board these devices allow for the creation of force despite the presence of a vacuum when these devices travel. That force produced by these devices can be calculated by the thrust equation. For the point, name these devices that help propel satellites into space
ANSWER: **rocket** engines [or **rocket**s; prompt on engine]

25. The 2002 Nobel Prize in Chemistry was awarded to John Bennett Fenn for inventing Electrospray Ionization as a means to ionize molecules for this technique. A cinnamic acid derivative is often used for the matrix in the softer MALDI ionization technique which results in lower fragmentation of the sample preceding this technique. This technique measures the m-to-z ratio of analytes obtained from a given sample. Often mistakenly referred to as a form of "spectroscopy" is, For the point, what technique that uses electromagnetism and certain quantity that gives rise to weight in order to separate analytes.
ANSWER: **mass spec**trometry

26. Euryhaline organisms highly regulate this process, while conformers to this process are termed stenohaline organisms A gradient caused by this process is reversed by the hormone ADH. This process causes the swelling of a plant's central vacuole creating turgidity. In general, this process stabilizes solute concentrations, which can result in a cell becoming hyper- or hypotonic. Pressure is used to "reverse" this process in a desalination method. Water moves through a semipermeable membrane during, For the point, what diffusive process?
ANSWER: **osmosis** [or **osmotic** flow; prompt on water flow; prompt on water balance; prompt on diffusion]

27. The relationship between computer programs and these constructs is given by the Curry-Howard correspondence. At the University of Illinois, Appel and Haken controversially used a computer to create one of these constructs. In geometry, Side angle side and angle side angle are sufficient for creating one of these constructs for triangle congruence. The two-column technique of creating these constructs is commonly taught in geometry. These constructs typically end with a square or Q.E.D. at the end. For the point, name this task of validating a mathematical theorem.
ANSWER: **proof**

28. A side profile portrait of this man is on the Fields Medal. Stories involving this man's contributions to defensive war efforts include telling generals to not disturb his circles and building a namesake "heat ray" which operated by reflecting the sun's rays off mirrors and onto incoming Roman ships. Though he never actually invented it, this man's description of an Egyptian screw pump that could raise water efficiently for irrigation is today known as his namesake screw. This scientist names the relation that the force of a liquid on a body is equal to volume of the body multiplied by its density multiplied by acceleration due to gravity. For the point, name this Greek polymath from Syracuse known for discovering his namesake principal related to buoyancy, allegedly while shouting "Eureka" in his bathtub.
ANSWER: **Archimedes** of Syracuse

29. The developer of a coefficient for this process, Sewall Wright, also defined the effective population size by a one-generation increase in either variance or this quantity. Before transplanting a pack of new wolves, Isle Royale only had two wolves left with a high coefficient of 0.438 for this process, a key contributor to the collapse of the population. The Westermarck effect helps explain why it doesn't occur often in humans. Plants enforce outcrossing via self-incompatibility in an effort to inhibit this process. A namesake depression occurs due to this process where deleterious recessive mutations are accumulated. This process results in increased homozygosity in a population. For the point, name this process where genetically similar organisms mate with each other.
ANSWER: **inbreed**ing [prompt on incest]

30. The internal resistance of this process can be ignored if the Biot number is sufficiently small. This process is aided by the diffusion of free electrons and can be modelled as the vibration of phonons. A law describing the rate of this process sets the flow due to it equal to negative k times area times d big T over d little t. Fourier's law describes this mode of heat transfer. The three principal forms of heat transfer include this one, convection, and radiation. For the point, name this form of heat transfer that occurs between two solid objects in contact.
ANSWER: heat **conduction** [prompt on heat flow; prompt on heat transfer]

Extra Question

31. Prince Rupert devised a problem involving this geometry such that one instance could pass through another and names the smallest one that will pass through one of unit size. The Delian problem concerns constructing the doubled volume equivalent of an object with this geometry. Of the 14 Bravais lattices, this category and orthorhombic share face-centered and body-centered variants. Algorithms such as F - U - R - U prime - R prime - F prime are performed in a game that uses this geometry. This geometry describes a right-angled parallelepiped, and the four dimensional analogue to this three dimensional geometry is the tesseract. For the point, name this platonic solid with six faces and twelve edges.
ANSWER: **cube**s