(MS) Science Bee Round 4

Regulation Tossups

(1)   Edsger Dijkstra's [[DEEK-struhs]] backtracking algorithm involves the arrangement of agents on one of these objects. A program called Stockfish has been applied to analyze agents on one of these objects. This object, which can be traversed using only L-shaped jumps, is the subject of a discrete mathematics problem about arranging eight of a certain piece such that they do not attack each other. For the point, name this eight-by-eight board, the subject of the eight queens puzzle.

ANSWER: **Chessboard** (accept **Checkerboard**)

(2)   These reactions are the subject of Marcus theory. This type of reaction occurs in galvanic cells, which are used to power batteries. The Nernst equation quantitatively expresses the outcome of this type of reaction. The mnemonic OILRIG is commonly used to remember the flow of electrons in this type of reaction. For the point, what type of reaction involves the loss and gain of electrons?

ANSWER: **Redox** reaction (or **Reduction-oxidation** reaction; prompt on descriptive answers)

(3)   This fundamental force's mediating particles can be described by the Gell-Mann matrices. Hideki Yukawa proposed that this force existed due to the pion. This force binds quarks together to form hadrons, and it also keeps hadrons together in atomic nuclei. For the point, name this fundamental force responsible for keeping protons and neutrons together in the nucleus.

ANSWER: **Strong** Force (or **Strong** Nuclear Force; accept **Strong** Interaction)

(4)   The first of these objects was discovered by Giuseppe Piazzi and named after the Roman goddess of agriculture. Other examples of these objects were named after Hawaiian, Inuit, and Rapa Nui deities. The term for these objects was coined by Alan Stern, though the International Astronomical Union rejects the implication that the objects qualify as certain larger bodies. For the point, name this type of object, whose most famous member was demoted to its ranks in 2006.

ANSWER: **Dwarf** Planet (do not accept or prompt on "Red Dwarf" or "White Dwarf")

(5)   This region was first conceptualized by A.E.H. Love and was further defined in Reginald Aldworth Daly's "Strength and Structure of the Earth." The boundary between this layer and what lies beneath it is often determined by the rheological differences between this layer and the asthenosphere. For the point, name this outermost layer, or "shell," of a terrestrial planet, composed predominantly of the crust and upper mantle.

ANSWER: **Lithosphere** (prompt on "crust" or "mantle")

(6)   The cell walls of these organisms contain pseudomurein, which cannot be degraded by lysozyme. Methanogens are a class of these organisms found in the digestive tracts of ruminants. The proposed kingdom of Monera included both bacteria and these organisms, which can be further classified as acidophiles, halophiles, and thermophiles. For the point, name this domain of prokaryotes that often inhabit extreme environments.

ANSWER: **Archaea** (accept **Archaebacteria**; prompt on "extremophiles"; do not accept or prompt on "bacteria")

(7)   The Kozak and Shine Dalgarno sequences are important for initiating this process in eukaryotes and prokaryotes respectively. Molecules bind to the A, P, E sites of an organelle in this process, which begins with the recognition of the start codon AUG or methionine. Initiation, elongation, and termination are the three steps of, for the point, what process in which ribosomes synthesize a protein from an mRNA sequence?

ANSWER: **Translation**

(8)   One type of this quantity is calculated with the bolometric correction. This quantity changes regularly for Cepheid variables, and it is plotted on the y-axis of a Hertzprung-Russell diagram. This quantity is 4.83 for the Sun, and the large star Vega has a value of 0.582 for this quantity. An "apparent" counterpart is contrasted with, for the point, what measure of an object's luminosity?

ANSWER: **Absolute Magnitude** (accept **Absolute** Visual **Magnitude**; prompt on "Magnitude;" prompt on "Luminosity;" prompt on "Brightness")

(9)   Ramsey's theorem explains that at a party with this many people, it is guaranteed that at least three of the guests either know or don't know each other. This number is the order of the smallest non-abelian group and appears in the denominator of the solution to the Basel problem. This is the smallest perfect number, and also the number of possible handshakes among 4 people. 3 factorial is equal to, for the point, what number that gives the number of sides in a hexagon?

ANSWER: **Six**

(10)   Wind forces lead these entities to move at a 90-degree angle from the direction of the surface wind in Ekman transport, and the Coriolis effect plays a large role in developing the "surface" variety of these entities. "Deep" varieties of these entities are driven by thermohaline circulation. Gyres are rotating examples of these entities, which include the Gulf Stream. For the point, name these large flows of water in the ocean.

ANSWER: Ocean **Current**s (accept **Gyre**s before mentioned)

(11)   These particles are released as part of the cooling operation of white dwarfs and neutron stars in the urca process. Unlike their antiparticle, these particles have left-handed chirality, as well as a neutron and positron. These particles are emitted during beta decay, and these fermions come in flavors that corresponds to leptons such as the electron, muon, and tau. For the point, name these nearly massless particles that interact via the weak force.

ANSWER: **Neutrino**

(12)   This hormone is synthesized by removing C-peptide by PC1 and PC2. This hormone, which regulates GLUT4 transporters, was sequenced by Frederick Sanger. Ketoacidosis is caused by a lack of this hormone, which stimulates the production of glycogen. Secreted from beta cells in the Islets of Langerhans, this is, for the point, what hormone that opposes the effects of glucagon, whose deficiency leads to type 1 diabetes?

ANSWER: **Insulin**

(13)   A matrix's eigenvalues can be calculated using the "characteristic" type of these mathematical objects. The Abel-Ruffini theorem says it is impossible to find algebraic solutions to these objects when their degree is greater than four. The power rule can be used to differentiate these objects, which can be divided using synthetic division. For the point, name these functions consisting of sums of the powers of variables.

ANSWER: **Polynomial**s

(14)   The Clausius inequality relates this quantity to heat and temperature. Trouton's rule states that this value for liquids undergoing vaporization is fairly constant. By the second law of thermodynamics, this quantity in an isolated system must increase through spontaneous evolution to reach thermodynamic equilibrium. Changes in this quantity are denoted S. For the point, name this quantity, the measure of disorder in a system.

ANSWER: **Entropy** (accept **S** before mentioned; prompt on "chaos" or "disorder")

(15)   Extractions of the Burmese variety of this substance have been in high demand, although its sale has caused controversy for helping fund the internal conflict in Myanmar. In 2020, scientists were able to extract ancient DNA from this substance, which stabilized the organisms inside, although the extraction of dinosaur blood from this substance is not as feasible as seen in the film *Jurassic Park*. Insects are commonly preserved in, for the point, what yellow-orange resin that comes from fossilized trees?

ANSWER: **Amber** (accept Burmese **Amber**; accept **Resinite**; prompt on "Resin" before mentioned)

(16)   The term 'syllable' was once used in place of this modern unit of measurement. Conflicts have arisen over whether the binary or decimal system should be used for this unit of measurement. The most common type of this unit is referred to by the Internet Protocol as an octet. For the point, name this unit of measurement for data size most commonly consisting of eight bits and expressed in kilo, mega and giga variants.

ANSWER: **Byte**s (accept kilo**byte**; accept mega**byte**; accept giga**byte**; accept tera**byte**; accept peta**byte**)

(17)   Anvil cells that use this mineral enable the compression of small materials to extreme pressures. Kimberlite pipes are often used to mine this mineral, which is placed at the tip of an apparatus in the Vickers test. This material, which is ranked above corundum on the Mohs scale, is a carbon allotrope consisting of a tetrahedrally bonded covalent network lattice. For the point, name this precious mineral, the hardest naturally occurring material.

ANSWER: **Diamond**

(18)   Individuals with the Delta-32 mutation are resistant to infection by this pathogen due to the inactivation of the protein C-C chemokine receptor 5. This pathogen can be treated by antiretroviral drugs such as Abacavir and AZT. Helper T cells, macrophages, and dendritic cells, are attacked by, for the point, what sexually-transmitted retrovirus that leads to a weakened immune response and can cause AIDS?

ANSWER: **HIV** (or **H**uman **I**mmunodeficiency **V**irus; accept **HIV**-AIDS; do not accept or prompt on "AIDS" alone)

(19)   Animals possess a reflective layer called the tapetum lucidum, which is in the organ that allows them to have this ability. Although humans cannot perform this ability, they are able experience it with a virtual reality device called the Tarsier Eclipse. An increased amount of high-density rod cells in the eyes allow animals to perform, for the point, what ability possessed by most nocturnal animals, such as owls, that allows them to see in the dark?

ANSWER: **Night** Vision (accept the description **see in the dark** or equivalents before mentioned)

(20)   This planet is the closest to Earth whose orbit is not predicted by the Titius-Bode law. Objects that are in 1:2 orbital resonance with this planet are called "twotinos." A triangular patch of clouds on this planet is known as the "Scooter," and a former series of storms on it was called the Great Dark Spot. A moon of this planet is the largest in the solar system to exhibit retrograde orbit, Triton. For the point, name this farthest planet from the sun.

ANSWER: **Neptune**

(21)   Optical tweezers use two of these devices to hold together microscopic objects. One of these devices was used to cool rubidium atoms into the first Bose-Einstein condensate. In the three-level type of these devices, pumping is used to energize the gain medium until it reaches a state of population inversion. Stimulated emission produces a coherent beam of very focused light in, for the point, what devices often found in barcode scanners and printers?

ANSWER: **Laser**s (accept **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation)

(22)   This quantity can be found by taking the square root of the product of vacuum permittivity and vacuum permeability. This quantity was shown to be the same in both directions in the Michelson-Morley experiment, disproving the existence of "aether wind." According to special relativity, this quantity is the same in all inertial reference frames. For the point, name this quantity symbolized c, the maximum speed at which matter in the universe can travel.

ANSWER: **Speed of Light** (accept **c** until mentioned)

(23)   These events can be detected by the presence of a "hook echo" pattern on a Doppler Radar. These events, examples of which include the landspout and waterspout varieties, and their intensity is measured by the TORRO and Fujita scales. A namesake "Alley" in the Central United States depicts, for the point, what meteorological events characterized by a violent funnel-shaped rotating cloud of air?

ANSWER: **Tornado**es (accept **Tornado** Alley; prompt on "Landspout" or "Waterspout" before mentioned)

(24)   The age of these type of markings found on the White Sands Desert in 2021 were approximated by radiocarbon-dating the seeds of ditchgrass. These markings, which are excavated by paleontologists through the process of lithification, were discovered by a team led by Mary Leakey in Laetoli and likely belonged to the *Australopithecus afarensis* species, providing evidence of bipedalism in early hominins. For the point, name these impressions that are left on a surface when a human or animal takes a step?

ANSWER: **Footprint**s (accept Laetoli **Footprint**s; prompt on "Prints" or "Tracks")

(25)   This scientist dropped out of the University of Pisa, but later returned and was named chief mathematician. This author of *The Assayer* utilized the telescope to discover that the moon had craters and mountains, which was contrary to contemporary belief that the moon's surface was smooth. For the point, name this Italian astronomer that was put under house arrest by the Catholic Church for his belief in heliocentricism.

ANSWER: **Galileo** **Galilei** (accept either)

(26)   This element has the highest ionization energy in the periodic table. Deuterium fuses with tritium to give an isotope of this element. Neon and this noble gas are found in a specific type of laser. The nucleus of an atom of this element is equivalent to an alpha particle, which has two protons and two neutrons. For the point, two hydrogen atoms can combine to form what noble gas, the second lightest and second most abundant element in the universe?

ANSWER: **Helium**

(27)   Foster's rule explains the population of animals in these ecosystems. Two oceanic plates colliding at a convergent boundary forms these landforms. The most famous example of adaptive radiation occurs in these ecosystems, which Charles Darwin investigated finches in. For the point, name these landforms surrounded completely by water, examples of which include Galapagos.

ANSWER: **Island**s (accept **Island** arc; accept Galapagos **Island**s)

(28)   This element's color is explained by relativistic effects of its 5d orbitals. It's not platinum, but a combination of nitric acid and hydrochloric acid is used to dissolve this metal. A foil of this element allowed Ernest Rutherford to discover the nucleus in a namesake experiment. Electrum is the alloy of silver and, for the point, what precious elemental metal whose purity is measured in karats?

ANSWER: **Gold** (accept **Au**)

(29)   A distinguishing feature of this disease is the presence of a polybasic site cleaved by furin that helps enhance its virulence. Methods for detecting this disease involve the use of lateral flow strips, the RT-LAMP method, or a real-time reverse transcription PCR reaction. The first confirmed case of this disease occurred in Wuhan and resulted in widespread lockdowns in China. Delta and Omicron are variants of, for the point, what infectious disease that has caused the ongoing pandemic?

ANSWER: **COVID**-19 (accept **SARS-CoV-2**; accept **Severe Acute Respiratory Syndrome Coronavirus 2**; accept **Coronavirus**; prompt on "Corona")

(30)   An EEG can measure stages one through four of this process, during which K-complexes occur. A disease commonly named for this process is known medically as trypanosomiasis [["trip"-ah-noh-SOH-mye-AY-sis]]. Muscle paralysis often occurs during the rapid eye movement form of this process, and obstruction of breathing can lead to its namesake apnea. People with insomnia struggle to undergo, for the point, what process which can include dreaming?

ANSWER: **Sleep** (accept REM **Sleep**; accept African **Sleeping** Sickness)

Extra Questions

(1)   Fibroids are smooth muscle tumors found in this organ, whose inner lining grows in the wrong location during endometriosis. A hysterectomy is the surgical removal of this internal organ, which is also cut open during a Caesarean section. The placenta forms within this organ after the embryo implants into its wall at the start of gestation. For the point, name this reproductive organ where the fetus develops.

ANSWER: **uterus** (or **womb**)

(2)   Diels-Alder reactions are accelerated when this molecule is used as the solvent. The enzyme catalase breaks down its substrate into oxygen and this compound. Combustion reactions produce carbon dioxide and the gaseous form of this compound. Carbon dioxide and this compound are the inputs into photosynthesis. For the point, name this "universal solvent" with chemical formula H2O.

ANSWER: **Water** (or **dihydrogen monoxide**; accept **H2O** before mentioned)