National Science Bee – Finals (IS)

Regulation Tossups

(1) **<u>One key step in making this thing involves blowing oxygen through molten metal to oxidize impurities like silicon, phosphorus, and manganese. (+)</u> The process to make this product involves reducing the content of one element in pig iron and adding alloying elements like chromium or nickel to produce its specialized forms. (*)** For the points, the Bessemer process is one way to make what alloy primarily composed of iron and carbon?

ANSWER: **<u>steel</u>** (accept **<u>stainless steel</u>**; do NOT accept "iron" at any point; prompt on "metal")

(2) **<u>This diagram includes a portion called the "instability strip". (+)</u> This diagram included a prominent band cutting diagonally across it called the "main sequence," and within this diagram, white dwarfs appear towards the bottom, while supergiants appear towards the top. (*)** For the points, identify this diagram named for Danish and American scientists, a scatter plot which maps the relationship between stars' luminosity and temperature.

ANSWER: **<u>Hertzsprung–Russell</u>** diagram (or **<u>HR</u>** diagram)

(3) **<u>Along with Proust's law, this man's pioneering statement of the law of multiple proportions led to the study of stoichiometry [[stoi-kee-AW-meh-tree]]. (+)</u> This scientist published a law stating that the total pressure in a mixture of gases is equal to the pressures of the individual gases. (*)** For the points, name this English scientist who pioneered modern atomic theory, arguing that elements were composed of atoms, which could form compounds.

ANSWER: John **<u>Dalton</u>** (accept **<u>Dalton</u>**'s Law of Partial Pressures; accept **<u>Dalton</u>** Minimum)

(4) **<u>Infantile-onset examples of this disease are marked by the appearance of a cherry-red spot within the retina. (+)</u> This disease is unusually common in French-Canadian, Cajun, and Ashkenazi Jewish communities. (*)** For the points, name this always-fatal disease which causes the destruction of nerves in the brain and spinal chord, named for two British and American doctors.

ANSWER: **<u>Tay-Sachs</u>** disease (accept **<u>GM2 gangliosidosis</u>** before "GM2" is mentioned)

(5) **<u>One of these areas called "Great Meteor" off the U.S. East Coast was responsible for escarpments called Corner Rise, along with intrustions in the White Mountains. (+)</u> Seamount chains can be created by these areas typified by basaltic rock, which are unusually warm areas of the mantle, responsible for the formation of the Yellowstone Supervolcano and Iceland. (*)** For the points, name these types of areas where magma rises into the Earth's crust, responsible for Hawaii's formation.

ANSWER: **<u>hotspot</u>**s

(6) **This astronomical object includes a crater called Gertrude, and it was discovered by William Herschel alongside Oberon. (+) This moon is the smallest in the outer Solar System to be its planet's largest moon. Named for a character in *A Midsummer Night's Dream*, (*)** this is, for the points, what largest moon of Uranus?

ANSWER: **Titania** (do NOT accept or prompt on "Titan"; accept **Uranus III**)

(7) **This property is the reason why an object sliding on a frictionless surface continues moving indefinitely. (+) Galileo's thought experiments on inclined planes helped establish the conceptual basis for this property, which contradicts Aristotle's idea that motion requires a continual force. (*)** For the points, name this subject of Newton's First Law of motion, the resistance to changes in motion.

ANSWER: **inertia**

(8) **Random ones of these things can be generated when a sequence is shuffled by the Fisher-Yates shuffle. (+) For a set of n distinct elements, there are exactly "n factorial" ones of these things. (*)** For the points, name these rearrangements of a set, in which the ordering of each element is potentially changed.

ANSWER: **permutation**s (do NOT accept "combinations")

(9) **High values for this property are related to low Secchi depths, which are determined by observing the point at which a black and white disk is no longer clearly visible. (+) Downhill movements of water filled with sediment make up this property's currents. (*)** For the points, name this property describing the degree of cloudiness in a water sample.

ANSWER: **turbidity** (prompt on "transparency" or "cloudiness"))

(10) **This website's markdown-based editor uses PageDown, a library forked from Markdown. (+) Users with sufficient reputation can flag posts on this website as duplicates, or edit questions tagged with technologies such as "python" or "java." (*)** For the points, name this question-and-answer website where programmers commonly debug code, a website named for a type of software error.

ANSWER: **StackOverflow**.com

(11) **The BOLD contrast technique is used in the functional form of this technology to track blood flow in real-time. (+) Patients being examined with this technology often consume contrast agents before being scanned. (*)** For the points, name this medical technology that uses magnetic fields to examine the body.

ANSWER: **magnetic resonance imagining** (or **MRI**)

(12) **These events, first detected by Vela satellites searching for nuclear tests, are divided into "long" and "short" categories lasting more or less than two seconds. (+) The merger of neutron stars can trigger these events, which are the most energetic electromagnetic phenomena known. (*)** For the points, name these brief but intense flashes of high-energy radiation from deep space.

ANSWER: **gamma ray burst**s (or **GRBs**; prompt on partial answers)

(13) **The virus responsible for this disease uses the ACE2 receptor to enter host cells, a process mediated by its glycoprotein. (+) This disease can trigger a hyperinflammatory immune response known as a cytokine storm, and its variants include Delta and Omicron. First identified in Wuhan in late 2019, it led to the rapid development of mRNA vaccines targeting its spike protein. (*)** For the points, name this pandemic viral disease.

ANSWER: **COVID**-19 (accept **coronavirus;** accept **SARS- 2**)

(14) **These numbers include all of the transcendental numbers, and these numbers are contrasted with a set often notated as " capital Q." (+) The square root of 2 is likely the first known member of this set of numbers. (*)** For the points, name this subset of real numbers including Euler's number and pi, which can't be expressed as a ratio of integers and repeats infinitely without a repeating sequence.

ANSWER: **irrational** numbers (or **Q** until mentioned)

(15) **A pseudovector measuring the amount of these units travelled per second is signified by the lowercase Greek letter omega. (+) One complete revolution measures as 2 pi of these units. One of these units is roughly equivalent to 57.3 degrees. (*)** For the points, name this unit for measuring angles taken from the length of an arc equivalent to the length of half of the diameter of a circle, often used in trigonometry.

ANSWER: **rad**ians

(16) **Ignaz Semmelweis was called the "savior of mothers" for his promotion of using chlorinated lime for this procedure to prevent postpartum infections. (+) In restaurants, this procedure helps prevent the spread of norovirus. (*)** For the point, name this practice that should be done for 20 seconds with warm water and soap after using the bathroom.

ANSWER: **hand washing** (accept equivalents such as **washing your hands**; accept [a]disinfecting[/i] in place of "washing"; prompt on "washing" or "hygiene" more generally)

(17) **A protocol to implement these services that performs better than IPsec [["I"-"P"-sek]] is WireGuard. (+) McAfee owns one of these services called TunnelBear, which features the use of AES-256 encryption and spoofing of IP [["I"-""P"]] addresses. (*)** For the points, name these services that extend a private system across other untrusted infrastructures, which include variants like Surfshark and a product prefixed "Nord."

ANSWER: **VPN**s (or **Virtual Private Network**; accept Nord**VPN**)

(18) **Tiger moths evolved a defense against this behavior that involves producing bursts of rapid clicks. (+) Along with communication, facilitating this behavior is the primary purpose of the ball of fat called a melon found in dolphins and whales. This behavior is used by bats to identify prey and navigate through tree branches. (*)** For the points, identify this behavior in which an animal uses reflected sound waves to navigate.

ANSWER: **echolocation** (accept equivalents like "using **sound** to **navigate**" until "navigate"; prompt after that)

(19) **Overactivity of these glands is a major factor in the development of acne vulgaris. (+) These glands secrete a substance that lubricates the skin and hair, preventing dryness and protecting against environmental factors. Primarily found in the dermis and associated with hair follicles (*),** these are, for the points, what holocrine glands that produce sebum?

ANSWER: **sebaceous** glands (accept **oil** glands)

(20) **This researcher proposed using cocaine to treat morphine addiction and referred his patient Emma Eckstein for a disastrous nasal surgery to treat "hysteria." (+) This researcher proposed that the unconscious was composed of the ego, superego, and id. (*)** For the points, name this Austrian neurologist and psychologist, the father of psychoanalysis.

ANSWER: Sigmund **Freud** (or Sigismund Schlomo **Freud**)

(21) **This autoimmune disorder targets oligodendrocytes, leading to the destruction of the myelin sheath that insulates nerve fibers. (+) It can present with relapsing-remitting or progressive forms and frequently leads to muscle weakness, fatigue, and coordination problems. (*)** For the points, name this neurological disease, abbreviated MS.

ANSWER: **multiple sclerosis** (accept **MS** before read)

(22) **When ethylene gas is reacted with this element, it creates a compound that was used as an additive to gasoline that had lead anti-knocking agents. A pest control agent containing this element and a (+) methyl group is also responsible for ozone depletion and has been limited in production by the Montreal Protocol. Used as a fire retardant and named for its pungent smell (*),** for the points, name this reddish-brown element that is a halogen and is a liquid at standard temperature and pressure.

ANSWER: **bromine** (or **Br**; accept ethylene **bromide**; accept **bromomethane**; accept methyl **bromide**; accept organo**bromine** compounds)

(23) **A mixture of methane, ammonia, hydrogen, and water was used in the Miller-Urey experiment, which found these things could be made when an electric arc was created. (+) Chains of these things are linked together to create peptides. (*)** For the points, name these compounds which have twenty-two proteinogenic forms essential for life, including alanine and cysteine.

ANSWER: **amino acid**s (accept proteinogenic **amino acid**)

(24) **This vector quantity is uniform in certain regions when created by a Helmholtz coil. An induced version of this quantity opposes the original version of this quantity per Lenz's law. (+) An electric current generates this quantity, which can be calculated by the Biot [[be-OH]]-Savart [[sah-VAR]] law. (*)** For the points, what vector field can be measured in teslas?

ANSWER: **magnetic** field (or **B**-field; or **H**-field; do NOT accept or prompt on "magnetic force" or "electric field")

(25) **The saturation ratio, which is the ratio of two forms of this quantity for a solution droplet and for pure water with a flat surface, appear in the Kohler equation in meteorology. (+) Examples of this quantity are multiplied by a mole fraction in Raoult's [[ROWTS]] law. (*)** For the points, name this quantity that measures the force exerted over area for a gas that is in equilibrium with a solid or liquid of the same substance.

ANSWER: **vapor pressure** (or **vapour pressure**; or equilibrium **vapor pressure**; accept water **vapor pressure**; accept **vapor pressure** of pure water; prompt on "pressure;" do NOT accept or prompt on "partial pressure")

(26) **Compounds with this interaction will lose a crystal lattice structure when undergoing solvation in solvents like water. (+) This interaction is exhibited in salts like sodium chloride, in which two atoms have large differences in electronegativities. (*)** For the points, identify this type of chemical bond, which is contrasted with a covalent bond.

ANSWER: **ionic** bond (accept **ionic** bonding)

(27) **A structure called the raphe releases mucilage, allowing these organisms to "glide." Two orders of these organisms include the Pennales and the Centrales. (+) Silicic acid is used to create the cell wall of these organisms, which generally have two thecae, and is called a frustule. (*)** For the points, name these unicellular organisms that are types of algae known as "jewels of the sea."

ANSWER: **diatom**s [[DYE-ah-toms]] (prompt on "algae")

(28) **The AuviQ type of these devices utilize a CO2-driven mechanism instead of a spring. Prior to use, a typically-blue safety release must be removed before the orange tip on the other side of these devices can be unlocked. (+) When self administered, patients swing these devices towards their thigh to ensure intramuscular delivery. (*)** For the points, identify these medical devices used to inject epinephrine to treat anaphylaxis.

ANSWER: **Epipen** (or epinephrine **autoinjector**; or adrenaline **autoinjector**)

(29) **The "Small Shelly Fauna" preceded this event, which saw the first appearance of trilobites and chordates. (+) Simon Conway Morris studied this period's rapid diversification of body plans, including the development of hard shells and exoskeletons. (*)** For the points, name this evolutionary radiation that saw most modern phyla appear around 541 million years ago.

ANSWER: **Cambrian explosion** (accept **Cambrian radiation** or **Cambrian diversification**; prompt on "Cambrian" or "Cambrian period")

(30) **This group includes rubidium, as well as the most reactive element in the periodic table, cesium. (+) This group is known for having all of its members be able to to form a cation with +1 charge, and its heavier members include francium. (*)** Forming group one of the periodic table with hydrogen are, for the points, what highly reactive metals including lithium and potassium?

ANSWER: **alkali** metals (do NOT accept or prompt on "alkaline earth metals"; prompt on "Group 1")

Extra Questions

(1) **This phenomenon is often funneled via mountain passes such as the Newhall and Cajon passes. This phenomenon is a type of katabatic wind which originates from a high-pressure area within the Great (+) Basin, and this phenomenon can also serve to carry valley fever into more populated areas. These winds which typically occur in autumn are also known as Diablo winds when they occur near (*)** San Francisco Bay. For the points, name these winds which often spread wildfires in Southern California.

ANSWER: **Santa Ana** winds

(2) **This physician gained fame treating gladiators and described the recurrent laryngeal nerve in dissected pigs. His theory of the four humors dominated Western medicine for over a millennium, and he incorrectly claimed (+) blood was produced in the liver. His work "On Anatomical Procedures" described the practice of vivisection, and he served as personal physician to Marcus Aurelius. (*)** For the points, name this influential Greek physician whose theories persisted until Vesalius.

ANSWER: **Galen** (or Aelius **Galen**us)

(3) **The Riemann zeta function and the polylogarithm appear in an ideal equation of state named for this man. This man developed a theory for particles that do not follow the Fermi-Dirac statistics, which in quantum statistics, explains how laser light is cohesive. (+) Paul Dirac coined a term for subatomic particles with integer spin, which references the name of this man. (*)** For the points, name this Indian physicist who, with Albert Einstein, shares his name with a state of matter occurring at low temperatures, which is called a condensate.

ANSWER: Satyendra Nath **Bose** (accept **Bose**-Einstein condensate; accept **Bose**-Einstein statistics; accept ideal **Bose** equation of state)