

Science Bee Semifinals

Regulation Tossups

(1) **A sharp tip with this property is attached to a cantilever and dragged along the surface of a sample in atomic force microscopy. Studies of Rochelle (+) salts led Jacques and Pierre Curie to discover this property, which is possessed by quartz. (*)** For the point, identify this property of materials that generate an electric voltage in response to applied mechanical stress.

ANSWER: **Piezoelectricity** (or **Piezoelectric** Effect)

(2) **Referred to as residual in one capacity, this force explains why free particles are required to have a color charge value of zero. Gluons experience (+) this force, which is responsible for the confinement of quarks and is the subject of quantum chromodynamics, or QCD. (*)** For the point, name this force which binds together the atomic nucleus, contrasted with a weak counterpart.

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

(3) **This region of the electromagnetic spectrum partly names a situation in which a blackbody emits boundless energy in a namesake "catastrophe." (+) Exposure to radiation in this part of the electromagnetic spectrum can lead to conditions such as photokeratitis of the eye. With a shorter wavelength than (*) visible light, this is, for the point, what type of radiation, excessive exposure to which can cause skin cancer?**

ANSWER: **Ultraviolet** Radiation (or **Ultraviolet** Light; accept **UV**)

(4) **According to "Polchinski's paradox," a billiard ball traveling through these entities can knock itself off course. The Schwarzschild (+) type of these entities are thought to contain an "Einstein-Rosen bridge," which is a tube connecting two exterior regions together. (*)** For the point, name these theoretical structures that connect two points of the universe, whose existence may prove the feasibility of time travel.

ANSWER: **Wormholes** (or Einstein-Rosen **Wormholes**; accept **Einstein-Rosen Bridges**; do not prompt on or accept "black hole")

(5) **One laboratory method used to measure this quantity packs the sample into a thin capillary tube, which is then viewed through a lens while it is heated in a heating block. (+) Ethylene glycol is added to car engines to lower this quantity, whose namesake "depression" is dependent on size. (*)** For the point, name this temperature at which a solid turns into a liquid, and which is zero degrees Celsius for water.

ANSWER: **Melting Point** (or **Melting Temperature**; accept **Freezing Point**; or **Freezing Temperature**)

(6) **The handling of this substance requires it to be slowly boiled to 77 Kelvin and stored and transported in vacuum flasks. (+) This substance's low boiling point is caused by the weak van der Waals interaction between its diatomic molecules. (*)** For the point, name this incredibly cold liquid used in cryotherapy and cryogenics.

ANSWER: Liquid **Nitrogen** (accept LN₂; or Liquid N₂)

(7) **Amazon Aurora is an engine on which these constructs can run, and Redis is used within these constructs whose desktop variety can be created by Microsoft Access. (+) Codd's 12 rules govern these constructs that can take the form of lakes or warehouses. Coming in relational and non-relational varieties, these constructs often make use of SQL. (*)** For the point, identify this structures collection of data in which files are often stored data.

ANSWER: **Databases** (accept Relational **Databases**; accept Non-relational **Databases**)

(8) **Notations used for this theory denote "A" as the central atom, "X" as bonding pairs, and "E" as lone pairs in the convention known as the AXE method. Strontium fluoride is an (+) exception to this theory, as its structure angles are 120 degrees between each bond instead of 180 degrees. (*)** Methane is a tetrahedral molecule according to, for the point, what theory that suggests the geometry of molecules is based on its number of electron pairs?

ANSWER: **VSEPR** [[VES-purr]] (or **V**alence **S**hell **E**lectron **P**air **R**epulsion)

(9) **The ventromedial nucleus is a feature in this structure that is responsible for thermoregulation and food intake. This organ's parvocellular cells (+) stimulate prolactin release, while its magnocellular cells synthesize vasopressin and oxytocin. It's not the pituitary gland, but the endocrine and nervous system is linked by, (*)** for the point, what small organ located below the thalamus?

ANSWER: **Hypothalamus** (do not accept or prompt on "Thalamus")

(10) **Elements such as hydrogen and helium are exceptions to this rule, since both only need to fill their s² orbitals. The electron (+) dot diagram is used to illustrate this principle by using lines to represent the bonding of atoms. Developed by Gilbert N. Lewis, this is, (*)** for the point, what rule that states that a chemical element is most stable when there are eight electrons in its valence shell?

ANSWER: **Octet** Rule

(11) **Anthropologists at Tel-Aviv University determined humans were this category of animals based on farming data from the Stone Age. The world's largest living (+) reptile fits into this category of animals, as do nearly all shark species. The *Anomalocaris* was one of the earliest known examples of these creatures, which occupy the highest trophic level in any ecosystem. No other organisms can (*) prey upon, for the point, what biological organism at the top of the food chain?**

ANSWER: **Apex Predators** (prompt on partial answer; accept **Top Predator**; accept **Top of the Food Chain** before mentioned)

(12) **The flattening of this muscle on an X-ray can help diagnose COPD, and involuntary spasms of this muscle produce hiccups. The volume of the (+) thoracic cavity is increased by this sheet of skeletal muscle that contracts to draw air into the lungs during respiration. (*) FTP, identify this muscle used by professional singers to produce powerful notes?**

ANSWER: Thoracic **Diaphragm**

(13) **Both males and females of this species are born with ankle spurs, but only the males use them to distribute venom. Another biological strength these prototherian mammals possess is a sense of electroreception that allows members of this species to find their prey by detecting electric fields. (+) Along with the echidna, this animal is one of the five remaining species of monotreme, (*) which are a type of mammal that lays eggs. For the point, name this semiaquatic, duck-billed mammal native to Australia.**

ANSWER: Duck-billed **Platypus**

(14) **Obstacles to this process can cause fork reversal and restart, which requires enzymes like topoisomerases that relieve supercoiling and helicases that separate the hybridized strands. (+) Okazaki fragments are synthesized on the lagging strand during this process, which occurs during S phase. (*) For the point, name this process that creates a copy of the cell's genome.**

ANSWER: **DNA Replication** (accept **DNA Synthesis**; prompt on "Replication" or "Synthesis" alone)

(15) **It's not Alzheimer's, but the Braak staging method describes the progression of this disease. Most cell-based therapies for this disease transplant tissue into the substantia nigra, (+) and the drug L-dopa treats this disorder, which is caused by the death of neurons that produce dopamine. (*) For the point, identify this neurodegenerative disorder whose symptoms include a shuffling gait and involuntary tremors.**

ANSWER: **Parkinson's** Disease (or **PD**; accept **Shaking Palsy**)

(16) **Among the incohesive types of rock that form at these regions are its namesake breccia and gouge. One type of these regions that occurs underwater can form a characteristic zigzag pattern and terminate at a (+) subduction zone. These planar regions can undergo a type of displacement called creep in the absence of (*) seismic activity. For the point, name these regions that can cause earthquakes, such as one named for San Andreas.**

ANSWER: **Faults** (accept **Fault** Line; accept **Fault** Trace; accept **Fault** Zone)

(17) **Low-lying debris can cause the crawling variety of these events, which can undergo a wind-induced phenomenon called "jumping." Distinguished from a (+) controlled variety that are used to manage their central environments, these events can be caused by lightning strikes and by the availability of (*) combustible vegetation. For the point, name these events characterized by heavy smoke and widespread burning.**

ANSWER: **Forest Fires** (accept **Wildfires**; accept **Bushfire**; accept **Wildland Fire**; accept **Rural Fire**)

(18) **The solid-state type of these devices uses crystalline or glass rods that are bombarded with ions of ytterbium, holmium, or thulium. (+) These devices are triggered when an electron drops to a lower energy level after being hit with a photon in a process called stimulated (*) emission. For the point, name these devices that emit a beam of light and are used in corrective eye surgery and handheld pointers.**

ANSWER: **Lasers** (or **Light Amplification by Stimulated Emission of Radiation**; accept **LASIK**)

(19) **A rare, naturally occurring form of this substance is called prasiolite. This mineral is naturally made of a (+) continuous framework of tetrahedra, and this mineral defines the value of seven on the Mohs scale of (*) hardness. For the point, identify this second-most abundant mineral in the Earth's crust after feldspar, a mineral composed of silicon dioxide?**

ANSWER: **Quartz**

(20) **This scientist's predictions regarding the motion of Mars came to be known as the Vicarious Hypothesis. (+) This scientist collected a set of data to help compute planetary positions known as the Rudolphine Tables and found that the length of the semimajor axis is proportional to planetary (*) orbital period. For the point, name this Early Modern German astronomer who developed three laws of planetary motion.**

ANSWER: Johannes **Kepler**

(21) **One form of this technique uses a reflectron to measure a sample's time-of-flight. "Soft" ionization techniques such as ESI and MALDI prepare samples for this process, which is often coupled with gas chromatography. (+) On spectra produced by this technique, the "base peak" represents the most abundant ion. (*)** For the point, name this analytic technique that separates fragments based on their mass-to-charge ratio.

ANSWER: **Mass Spectrometry** (or **Mass Spectroscopy**; or **MS**; accept Time-of-flight **Mass Spectrometry**; accept GC-**MS**)

(22) **William Lassell discovered this planet's largest orbiting body just a little over two weeks after this planet's discovery. Despina is a satellite of this planet whose existence was predicted in part by (+) Urbain Le Verrier's calculations. Features of this planet include the Adams Ring, as well as a series of anticyclonic storms within its Great Dark Spot. (*)** Triton is the largest moon of, for the point, what planet whose astronomical symbol resembles a trident, the eighth planet from the sun?

ANSWER: **Neptune**

(23) **The herringbone variety of these items consist of a duo of side-by-side helical types of these items. Chevrons on the sides of these devices inspired the logo of Citroën, (+) and these components comprise sets whose mechanical advantage can be defined by a namesake ratio. Often containing teeth, these items create speed from torque and are alternatively known as (*)** cogs. For the point, name these circular components that one can shift when driving a car.

ANSWER: **Gears** (accept **Gearbox**; or Herringbone **Gear**; or Double Helical **Gear**; or **Gear Transmission**; accept **Cogs** before mentioned)

(24) **One type of this process is necessary for converting crude oil into a form that can be stored in atmospheric tanks, and that variety of this technique is known as stabilization. (+) This process can follow fermentation in a technique in which alcoholic beverages become liquor. (*)** Coming in partial and fractional forms, this is, for the point, what laboratory process that separates components of a liquid mixture?

ANSWER: **Distillation** (accept Fractional **Distillation**; accept Partial **Distillation**; accept Destructive **Distillation**)

(25) **According to this principle, two people will share the same birthday in any given room of at least 367 people. Commonly known as Dirichlet's box principle, (+) this mathematical statement explains that when n items are put into m containers if n is greater than m , then at least one container will have more than one item. (*)** For the point, name this combinatorial principle inspired by the roosts of a certain urban bird.

ANSWER: **Pigeonhole** Principle (accept **Dirichlet's Box** Principle before mention)

(26) **This function appears in the imaginary parts of both Demoivre's [[de-MWAHV]] and Euler's formulas. The terms in this function's Taylor series contain odd exponents divided by odd factorials. (+) This function is positive in the first and second quadrants because it gives the y-coordinate on the unit circle. Cosecant is the reciprocal of, (*)** for the point, what trigonometric function, which, in a right triangle, equals the opposite side over the hypotenuse?

ANSWER: **Sine** (or **Sin X**)

(27) **This event was followed a month later by a similar one involving Philip Blaiberg. The overseer of this effort was helped by his brother, Marius, in providing a Lithuanian-born grocer named (+) Louis Washkansky with the central entity at Groote Schuur Hospital. Taking place in Cape Town in 1967, this is (*)** for the point, what event in which Christiaan Barnard surgically provided a certain organ to a patient with congestive failure?

ANSWER: **First Heart Transplant** from Human to Human (accept **Heart Transplant** of Christiaan Neethling **Barnard**; prompt on partial answers)

(28) **The Banker's algorithm that aims to prevent deadlock was developed for one of these entities named for the Eindhoven University of Technology. Hypervisors can be used to run guest versions of these entities on top of a host system through the process of virtualization. (+) Prioritization of I/O operations can be accomplished by the schedulers in these entities, which contain a kernel. (*)** For the point, name these low-level computer programs that include Linux and Windows.

ANSWER: **Operating Systems** (accept **OS**; accept THE **Operation System**)

(29) **The James Webb Space Telescope contains 18 gold-layered fixtures of this element that serve as mirrors. Two nuclei react to form an unstable version of this element before the creation of carbon in the triple-alpha process. (+) Aquamarine and emerald are both varieties of a mineral that lends its name to this element that lies above (*)** magnesium on the periodic table. For the point, name this element with atomic number 4 and symbol Be.

ANSWER: **Beryllium** (accept **Be** before mentioned)

(30) **Lazzaro Spallanzani originally discovered these organelles, which he labelled as "stars." These organelles can facilitate increased germination speed by expanding, and (+) osmoregulation takes place within one variety that can undergo expansions, while its other variety completes the opposite process. (*)** The contractile variety compartmentalizes enzymes in, for the point, what water-filled organelles involved in storage.

ANSWER: **Vacuole** (accept Contractile **Vacuole**)

Extra Questions

(1) **Joseph Petzval challenged this effect because he thought the equations were too basic to explain any natural phenomena. (+) Buys Ballots tested this phenomenon by having a group of musicians play the same note while on a moving train. Developed by a 19th century Austrian physicist, this is, (*)** for the point, what phenomenon that explains why a sound is heard louder as its source approaches an observer?

ANSWER: **Doppler** Effect (or **Doppler** Shift)