

Science Bee – Final Round (2nd & Under)

Regulation Tossups

(1) **This group of animals uses specialized vascular structures called *retia mirabilia* to regulate oxygen supply during deep dives. One subgroup of these animals, the “earless” forms in the family *Phocidae*. (+) moves on land by undulating its body rather than rotating its hind flippers forward. These animals belong to the clade Pinnipeds, which also includes (*) sea lions and walruses. For the points, name these marine mammals known for their whiskered faces and flippers.**

ANSWER: **seals**

(2) **Failure to produce hormones from this gland can be a cause of fatigue or weight gain in Hashimoto's disease. (+) Graves' disease can cause eye-bulging and, and the enlargement of this gland, which produces metabolic and cardiovascular hormones, is largely caused by iodine deficiency (*) and is called goiter. For the points, name this endocrine gland, a butterfly-shaped set of lobes in the neck.**

ANSWER: **thyroid** gland

(3) **The bulk variety of this process relies on vesicles, and that variety of this process is used for substances that are too large for membrane proteins. The secondary form of this process relies on electrochemical gradients. (+) whereas the primary form uses ATP as an energy source. Exemplified by the sodium-potassium pump, for the points, (*) what is this cellular process which moves compounds against the concentration gradient, unlike its passive counterpart?**

ANSWER: **active transport** (prompt on “transport”)

(4) **This process results in a change in angular momentum when it undergoes Gamow-Teller transitions. This process is a consequence of the fact that the weak force allows for quarks to change their flavor, which is mediated by a virtual (+) W boson. This process changes the atomic number of a particle, but not its nucleon number, by converting a neutron into a proton. (*) For the points, name this type of radioactive decay which results in an electron or positron being released.**

ANSWER: **beta** decay (prompt on “decay” before mentioned)

(5) **The protein expansin leads to disproportionate cellular osmosis in this phenomenon. This phenomenon makes use of signaling molecules and the hormone (+) auxin to cause ionic movement. A negative form of this phenomenon occurs in some roots, which often (*) grow away from a certain stimulus. For the points, name this phenomenon of growth in which a plant changes its direction of orientation in response to light.**

ANSWER: **phototropism** (accept **growing towards light** or equivalents before “light” is said)

(6) **The Hipparcos mission dramatically improved measurements of this effect by reducing uncertainties to micro-arcsecond precision. The failure to detect stellar examples of this phenomenon was used as an argument against heliocentrism until Friedrich (+) Bessel successfully measured it for the star 61 Cygni in 1838. The diurnal form of this effect is observed from different points on the Earth's surface. (*)** For the points, name this apparent shift in the position of an object when viewed from different locations.

ANSWER: **parallax**

(7) **This structure's vestibular duct contains perilymph inside. This structure also contains Reissner's membrane, which can be damaged in a condition called (+) Ménière's disease. This structure makes roughly 2.75 turns around the modiolus, and it contains the organ of Corti, which is important for transduction of (*) auditory signals. Also able to generate and amplify sound, for the points, what is this spiral snail shell-like part of the inner ear?**

ANSWER: **cochlea** [[KOK-lee-uh]] (prompt on "ear")

(8) **As a young man, this physician was apprenticed to the surgeon John Hunter, who advised him, "Don't think, try." This man's most famous experiment was based on the observation that (+) milkmaids who had contracted a mild disease were immune to a more serious one. An eight-year-old boy, James Phipps, was the subject of an (*) inoculation conducted by this man. For the points, name this English physician who pioneered the concept of vaccination by showing that cowpox could protect against smallpox.**

ANSWER: Edward **Jenner**

(9) **When x equals this number, the function "x to the power of one divided by x" takes its maximum, per Steiner's problem. Jacob Bernoulli defined this number while studying compounding interest, stating this number as the limit as n approaches infinity of (+) "one plus one divided by n, to the power of n." An identity named for one mathematician says that "one plus this number raised to the power of (*) i times pi equals zero." For the points, name this mathematical constant, sometimes named for Leonhard Euler [[OY-lur]].**

ANSWER: **e** (accept **Napier's** constant; accept **Euler's** [[OY-lurs]] number before "Euler")

(10) **An equation that modifies this law by adding correction factors for intermolecular forces and molecular volume is named for a Dutch scientist. This law includes a constant of proportionality of roughly 8.314 joules per mole-kelvin. (+) This law combines the findings of earlier scientists, including one who found that pressure is inversely proportional (*) to volume. For the points, name this equation of state often written as "PV equals nRT."**

ANSWER: **ideal gas** law

(11) **One of these control flow constructs can be broken into multiple instances in a compiler optimization called fission. "i," "j," and "k" can be used as names for variables that act as (+) counters when controlling iterations of these control flow constructs, which may have a "continue" statement, allowing for skipping to the next iteration. (*)** For the points, name these control flow constructs which regulate how many times code repeats and comes in "while" and "for" varieties.

ANSWER: **loops** (accept while **loop**; accept for **loop**)

(12) **Friedrich Miescher was the first to isolate these molecules in 1869, and Albrecht Kossel won the Nobel Prize for Physiology or Medicine in 1910 for determining these molecules' chemical composition. (+)** In 1944, an experiment by Oswald Avery, Colin MacLeod, and Maclyn McCarty proved that these molecules cause bacterial transformation. (*) For the points, name these types of acids, whose double helix structure was proposed by James Watson and Francis Crick in a molecule carrying genetic information.

ANSWER: **nucleic acids** (accept **DNA** or **deoxyribonucleic acid**; accept **RNA** or **ribonucleic acid**)

(13) **This person disproved the Aristotelian theory of celestial immutability by observing a phenomenon in the constellation Cassiopeia. This scientist built Uraniborg, the first large (+) observatory in Christian Europe, with funding from Frederick the Second. In this scientist's namesake planetary model, the Sun orbits the Earth and the rest of the planets orbit the Sun. Johannes (*)** Kepler once worked with, for the points, what Danish astronomer who developed more precise instruments of celestial observation?

ANSWER: **Tycho Brahe** [[TIH-koh BRAAH]] (accept either underlined portion; be lenient on pronunciation; accept Tyge Ottesen **Brahe**; accept **Tychonic** system; accept **Tychonian** system)

(14) **This constellation contains a star which has two hemispheres separately dominated by helium and hydrogen, called Janus. This constellation contains a cloud with Pickering's Triangle, (+) located in its namesake "loop." The first observed black hole was in this constellation, which contains the "Galactic Ghoul," and its star Deneb forms the (*) head of the Northern Cross. For the points, name this constellation whose name is derived from a word for "swan."**

ANSWER: **Cygnus** (accept **Cygnus** X-One; accept **Cyg** X-One; accept **Cygnus** Loop)

(15) **ELVES is a type of lightning that occurs at the lower boundary of this layer of the atmosphere. The aurora occurs in this layer of the atmosphere, (+) which can reach temperatures above 2,000 degrees Celsius due to the pronounced effects of solar radiation. The International Space Station and many other (*) low Earth orbit satellites are found within this layer. For the points, name this layer of the atmosphere, located above the mesosphere.**

ANSWER: **thermosphere**

(16) **This group of microorganisms were defined by Carl Woese [[WOHZ]] by using 16S ribosomal RNA. Members of these microorganisms called methanogens inhabit the gastrointestinal tract of humans and herbivores to aid in digestion. (+)** This group of microorganisms are known for being extremophiles, often living in very salty areas or (*) hot springs. For the points, name this group of microorganisms, one of the three domains of life alongside Bacteria and Eukaryota.

ANSWER: **Archaea** [[ar-KAY-uh]]

(17) **The number of scintillations that occurred during this experiment was observed using a zinc sulfide sheet. This experiment, which used radon-222 as a particle source, was carried out by, and is sometimes named for, Hans Geiger and Ernest (+) Marsden. This experiment observed the deflection of alpha particles by a thin sheet of metal, disproving J. J. Thomson's (*) plum pudding model. For the points, name this experiment which proved the existence of the atomic nucleus, designed by Ernest Rutherford.**

ANSWER: Rutherford **gold foil** experiment (accept **Rutherford** scattering experiment before "Rutherford" is mentioned; accept **Geiger-Marsden** experiment before "Geiger" is mentioned)

(18) **The complexometric type of this process utilizes organic dyes such as Eriochrome Black T, alongside a chelator like EDTA, to determine the hardness of water by detecting metal ions. (+)** Polyprotic compounds that undergo this process possess multiple inflection points. This process reaches the equivalence point when a pH indicator, such as phenolphthalein, (*) changes color. For the points, name this laboratory technique that uses a burette to add a solution drop by drop.

ANSWER: **titration** (accept word forms like **titrating**)

(19) **Vertices of the Calkin-Wilf tree represent these numbers. An extension of these numbers involving digits based on a prime number are called *p*-adic numbers. (+)** This set of numbers is countable and has a decimal representation that either repeats forever or terminates with a finite number of digits. Written as a (*) boldface Q, for the points, name these numbers that can be described as fractions with integer numerators and denominators.

ANSWER: **rational** numbers

(20) **The process of Q-switching in these devices produces high-power pulses, while mode-locking creates ultrashort pulses. These devices require an optical cavity bounded by mirrors to achieve stimulated emission (+) through multiple passes, and semiconductor variants of these devices power fiber optic communications and DVD players. (*)** For the points, name these devices that produce coherent, monochromatic light beams.

ANSWER: **lasers** (or **light amplification by stimulated emission of radiation**)

(21) **The circulation these environments is modeled by the Pritchard classification system, which categorizes them into salt-wedge and highly stratified varieties. Coastal-plain varieties of these location form when (+) rising sea levels drown existing river channels. Dominated by highly dynamic tidal mixing, these locations (*) include Chesapeake Bay. For the points, name these coastal bodies of brackish water where rivers meet the ocean.**

ANSWER: **estuaries** (accept salt-wedge **estuaries** or highly stratified **estuaries** or coastal-plain **estuaries**; accept **estuary**)

(22) **A persistent, hexagonal-shaped cloud pattern exists at this planet's north pole. A massive storm known as the "Great White Spot" periodically erupts in this planet's northern hemisphere. (+) This planet's largest moon was explored by the Huygens probe, and this planet is the only one with a lower density than water, technically making it (*) "floatable." Titan is the largest moon of, for the points, what sixth planet from the Sun, famous for its extensive system of rings?**

ANSWER: **Saturn**

(23) **This concept's mathematical expression includes a namesake parameter often denoted lowercase f, equal to twice Earth's angular velocity times the sine of latitude. This is the primary effect which contributes to geostrophic balance. (+) and though often mistakenly invoked to explain small-scale phenomena like draining sinks, (*) this effect is negligible at those scales due to insufficient spatial extent and time. For the points, name this apparent deflection of moving objects caused by Earth's rotation.**

ANSWER: **Coriolis** effect or force

(24) **Transfer of this compound caused a boiling liquid expanding vapor explosion in the Doxol disaster in Kingman. This is the primary gas used in blowtorches, (+) and it is the main fuel to allow for the operation of hot-air balloons. After diesel and gasoline, this compound is the most popular vehicle fuel, (*) which is used as autogas. For the points, name this alkane that forms part of liquefied petroleum gas and is used to provide fuel for cooking on barbecue stoves.**

ANSWER: **propane** (or **C3H8**)

(25) **One of the earliest recordings of these astronomical events was observed by Chinese and Islamic astronomers from 1054 to 1056. One of these events was observed in the Cassiopeia constellation (+) in 1572, and some of the most-likely candidates for the occurrence of these events in the near future are red supergiants, including Antares and Betelgeuse. The formation of (*) neutron stars and black holes are the result of, for the points, what luminous explosions of stars?**

ANSWER: **supernovae** (accept Crab **supernova**; accept Tycho's **supernova**; prompt on "nova" or "novae")

(26) **These constructs require the use of voussoirs, a type of stone placed together, with the stones at both ends also designated as springers and resting on abutments. 167 of these features were used in the Segovia Aqueduct to save materials while also avoiding (+) collapse. One modern example of these creations was built with a rotating elevator that was described as "half Ferris wheel." A (*) keystone is often the highest part of, for the point, what type of structure exemplified by a Missouri "gateway?"**

ANSWER: **arch** (or **archway**; accept Gateway **Arch**)

(27) **This quantity is estimated as "two times pi times the effective radius times a function of interactive energy per unit area" in the Derjaguin approximation. Examples of this quantity include a variant proportional to (+) "angular velocity squared times radius," which arises in a rotating frame of reference, and is the (*) "centrifugal" type. For the points, name this quantity which is measured in newtons and equals mass times acceleration.**

ANSWER: **force** (accept interaction **force**; accept centrifugal **force**; accept fictitious **force**; accept inertial **force**)

(28) **This language's 1999 standard includes data types like imaginary, complex, and long long, while that version also included constructs like the restrict keyword and variable-length arrays. (+) This language with a K and R manual was used to reimplement part of the Unix operating system. Dennis Ritchie invented, (*) for the points, what programing language that inspired a "plus plus" successor?**

ANSWER: **C** (do NOT accept or prompt on "C Plus Plus" or "C Sharp" or "Objective C")

(29) **This organism created verotoxin, a Shiga-like toxin that could kill Vero cells. Edward Tatum and Joshua Lederberg used this model organism as the first researchers to understand (+) bacterial conjugation. ETEC is a form of this organism, which can cause (*) abdominal cramps. For the points, name this coliform bacteria found in the intestine, which can sometimes cause vomiting and diarrhea through food-borne illness.**

ANSWER: **E. coli** (or **Escherichia coli**; prompt on "bacteria" before mentioned)

(30) **This man's most famous creation was originally developed using data from the Wood-Anderson variety of one measuring device. With Beno Gutenberg, this man co-authored the book (+) Seismicity of the Earth. The measure this man developed is logarithmic, with each whole number representing a (*) tenfold increase in amplitude. For the points, name this Caltech seismologist who co-created a namesake scale for measuring the magnitude of earthquakes.**

ANSWER: Charles **Richter** (or Charles Francis **Richter**; accept **Richter** Scale)

Extra Questions

(1) Using the Fresnel [[fry-NEL]] equations, it is possible to find that light does not undergo this phenomenon when the angle of incidence is equal to the arctangent of the ratio of refractive indices, per Brewster's law. (+) The critical angle defines the smallest angle for which the total internal form of this phenomenon occurs. (*) For the points, name this phenomenon in which light goes back to the medium it started in, instead of crossing into another medium.

ANSWER: reflection (accept total internal reflection; accept TIR [[T-I-R]]; accept total reflection)

(2) The prograde Himalia group comprises several of this body's irregular satellites, which, like the retrograde Pasiphae group, formed elsewhere and were captured by this object's gravity. This planet is orbited by eight regular satellites, of which (+) Adrastea is the smallest, and this body is orbited by Amalthea between its two faint Gossamer Rings, which lie to the outside of this planet's (*) Main Ring and Halo. For the points, name this planet, a gas giant with four major satellites referred to as Galilean moons.

ANSWER: Jupiter

(3) The ring type of this construct is demonstrated by the Larus group of seagulls around the Arctic. A philosophical problem named for trying to define these constructs is named for Ernst Mayr. (+) Biological, phylogenetic, ecological, and morphological concepts are used to define these constructs, and a common criterion for defining these constructs involves (*) reproductive isolation. For the points, name this taxonomic grouping whose *Origin* is the subject of a book by Charles Darwin.

ANSWER: species (accept ring species; accept *On the Origin of Species*)