



National Science Bee Prelims - Round 2

1. This region, which includes “hot” and “cold” populations, has its namesake “cliff” at 1 to 2 resonance. NASA’s *New Horizons* mission is currently exploring this region, where cubewanos like the dwarf planet Makemake can be found. The only moon with a retrograde orbit in the solar system, Triton, was once an object in this region before it was captured by Neptune, beyond which this region extends. For the point, Pluto resides in what region of space that is named for a Dutch-American astronomer?

ANSWER: Edgeworth-**Kuiper belt**

2. In 2017, an oral vaccine was developed to protect this animal against sylvatic plague, thereby helping increase the population of this animal’s main predator, the critically-endangered black-footed ferret. This animal executes the “jump-yip” to warn members of its coterie, who often identify each other by kissing. A classic example of a “keystone species,” this animal comes Gunnison’s, Utah, and black-tailed varieties. For the point, name this rodent that lives in underground burrows.

ANSWER: **prairie dogs**

3. Amide groups in enzymes can take advantage of this phenomenon to create “oxyanion holes” in order to stabilize charged transition states. Three atoms share four electrons in this interaction’s “symmetric” type,” which occurs in the bifluoride ion. Antiparallel beta-sheets are slightly more stable than parallel ones due to this interaction that defines the secondary structures of proteins. For the point, name this dipole-dipole interaction between electronegative atoms and a namesake element.

ANSWER: **hydrogen bonding** (accept **H bonding**; prompt on “hydrogen” or “H” alone)

4. When preceded by the word "linear," this term describes an expression produced by adding together terms with constant coefficients. The calculations for the total number of possible lottery tickets or possible poker hands follow this type of calculation, whose formula involves three factorial signs and is often described as "n choose k." For the point, give this mathematical term for a selection of objects without care for their order, unlike a permutation.

ANSWER: **combination** (accept **binomial coefficients**; prompt on "choose" or "n choose k" before mentioned)

5. The change in this quantity with respect to internal energy defines the reciprocal of temperature. The basic definition of this property is that it is equal to the Boltzmann’s constant multiplied by the natural log of the total available microstates. This quantity is zero for a reversible process, but can never be negative by the second law of thermodynamics. For the point, name this property that is typically associated with the amount of disorder in the universe.

ANSWER: total **entropy**

6. Uranium hexafluoride is enriched through a variant of this process, whose namesake coefficient is related to mobility, Boltzmann’s constant, and temperature in the Einstein Relation. The rate of this process in gases is inversely proportional to the square root of their molar masses, according to Graham’s Law. Fick’s Law uses a concentration gradient to explain this process. For the point, particles move from areas of high concentrations to those of low concentrations in what process?

ANSWER: **diffusion**

7. The triacontahedron [[try-a-con-ta-heed-ron]] has this shape for its faces. The dice lattice is a planar tiling using these shapes with 60 and 120 angles. The diagonals of this type of polygon bisect each other, and their area is half the product of the diagonal lengths. Three of these quadrilaterals can be arranged into a regular hexagon. Equilateral examples of this type of quadrilateral are squares. For the point, name this type of quadrilateral with four equal sides.

ANSWER: **rhombus**

8. In one type of this process, the Van Deemter equation relates factors involved in band broadening to the height equivalent to a theoretical plate. This technique's results are often visualized with iodine vapors or ultraviolet light. Silica gel is used as a stationary phase in the "thin-layer" type of this process, whose retention factor measures the ratio between distance traveled by the sample and distance traveled by the solvent. For the point, what chemical process is used to separate mixtures?

ANSWER: **chromatography**

9. This phenomenon's existence in matter was proposed by Louis de Broglie in 1924. Two rotating black holes created the gravitational version of this phenomenon that was detected by LIGO in 2016. The namesake "length" of this phenomenon is equal to its speed over frequency, and it comes in transverse and longitudinal varieties. For the point, name these periodic disturbances which are exemplified by light and sound.

ANSWER: **waveforms**

10. This geologic period's beginning is agreed to be the emergence of trace fossils known as Treptichnus pedum, although the organism leaving these fossils was not preserved. This period was followed by the Ordovician Period and is the first period of the Paleozoic Era. The Burgess Shale in Canada is a lagerstätte, or sedimentary deposit with well-preserved fossils, from this period. This period marked some of the first known animals to venture onto land. For the point, name this geologic period with a namesake "explosion" of diverse and complex life on Earth.

ANSWER: **Cambrian** Period

11. In the unit circle, a point's height along the y-axis represents the value of this function for the appropriate angle. This trigonometric function, whose graph passes through the origin and has a period of 2π , is positive for all acute, right, and obtuse angles. In a right triangle, this function for an acute angle is equal to the length of the opposite side over the hypotenuse's length. For the point, name this basic trigonometric function whose co-function adds the prefix co- to its name.

ANSWER: **sine** function

12. Transactions within these things must be atomic, consistent, isolated, and durable, commonly abbreviated as "ACID". Mongo and Apache Couch are two commonly used programs to work with these things. Commands such as "Join" and "Select" are used to access specific parts of these things. The language SQL ["sequel"] can perform queries on the relational types of these things. For the point, name these large data collections often displayed as tables.

ANSWER: relational **database**

13. Species that lack these structures are called gynoeceous. In one part of these structures, stomium cells degenerate so that dehiscence can occur. According to the ABC model, mutations in genes *APETALA3* and *PISTILLATA* lead to the formation of carpels instead of these structures in *Arabidopsis thaliana*. One part of these structures contains microsporangia, which develop into gametophytes that are released as pollen grains. For the point, name these male organs in flowers that consist of both filaments and anthers.

ANSWER: **stamens**

14. P-bodies store molecules necessary for this process, which begins in eukaryotes after Kozak's sequence is recognized. Release factors mediate the end of this process, and during it, GTP hydrolysis powers translocation, where elongation factors help move a certain molecule from the P site to the A site. Wobble base pairing accounts for why an anticodon of t-RNA can pair with more than one codon during this process. For the point, what process occurs in ribosomes and creates proteins from mRNA?

ANSWER: **translation**

15. Dr. William Farr was the leading proponent of the "Miasma" theory of this disease, which claimed it was caused by decomposing matter being released into the air around a river. An outbreak of this disease was traced back to the Broad Street pump by John Snow; that 1854 outbreak occurred in the Soho district of London. Diarrhea and vomiting are symptoms of, for the point, what disease that can be caused by drinking contaminated water?

ANSWER: **cholera**

16. Seracs are blocks or columns formed within these objects as crevasses intersect. Cup-like valleys known as cirques are created by these objects on mountainsides, while moraines are made up of the debris left behind by these objects' movement. These objects often appear blue, largely due to the absence of air bubbles, an effect caused by the density of ice. For the point, name these large, dense sheets of ice that cover about 10% of the Earth's surface and contain much of its fresh water.

ANSWER: **glaciers**

17. The name for these spacecraft derived from a scrapped NASA mission to visit Mars. The "Pale Blue Dot" photograph of the Earth was taken by one of these spacecraft. These spacecraft were conceived in the aftermath of NASA's failed "Grand Tour" project. In 2012, one of these spacecraft was the first man-made object to leave the solar system. For the point, name this pair of spacecraft that went to study the four outer planets.

ANSWER: **Voyager** 1 and 2

18. In Griffith's experiment, this substance was why a mixture of a non-infecting "rough" strain and an infecting "smooth" strain killed mice, a fact later confirmed by the "transforming principle." Phoebus Levene's theory about this substance was corrected by Erwin Chargaff, whose namesake rules state that this substance has a 1 to 1 ratio of pyrimidine and purine bases. For the point, Watson and Crick discovered the double helical structure of what molecule that carries human genetic material?

ANSWER: **deoxyribonucleic acid** (or **DNA**)

19. Gyroscopic precession refers to precession induced by this phenomenon that for a charged particle can be calculated by crossing the dipole moment with the electric field. This quantity which can be measured in newton-meters or joules per radian is equal to the angular acceleration times the moment of inertia. Defined as the cross product of radius and force, it's direction can be found using the right hand rule. For the point, name this twisting force that causes rotation.

ANSWER: **torque**

20. The motto for the French Revolution lends names to the arcs of a ring that surrounds this object. James Challis, George Airy, and John Couch Adams predicted the location of, but failed to observe, this object. This object is home to visible storms such as the Scooter and the Great Dark Spot. The cryovolcanic moon Triton orbits this object. For the point, name this object discovered after anomalies predicted a planet outside of the orbit of Uranus.

ANSWER: **Neptune**

21. Alkyl groups are bonded to elements from this group in products of the Hunsdiecker-Borodin reaction. Members of this group bind to each other to form “inter” varieties, and one member is used in Lugol’s solution to stain starches blue. In organic chemistry, a test named for an element from this group determines if a solution has carbon-carbon double bonds. Purple gas is formed when another member of this group sublimates. For the point, name this group of elements that includes bromine and iodine.

ANSWER: **halogens** (accept **Group 17** and **Group 17A**)

22. Ferdinand Lindemann showed that a square with this area could not be constructed with compass and straightedge because this number is transcendental. The probability that a random point in a square is within a side length of a given corner is one-fourth of this number. This period of the tangent function is equal to half of tau. The area of the unit circle is, for the point, what number equal to the circumference of a circle divided by its diameter?

ANSWER: **pi**

23. The 1960 Nobel Prize in Chemistry was awarded for the discovery of this process to Willard Libby, a professor at the Institute for Nuclear Studies. This process is possible due to the absorption of a particular element by plants and animals, some of which was created by cosmic rays interacting with atmospheric nitrogen. This process then measures the amount of a certain isotope of that element left in such organic material after it has radioactively decayed over time. For the point, name this process by which isotope 14 of an element is used to measure the age of organic material.

ANSWER: radiocarbon dating [or carbon-14 dating; prompt on “dating”]

24. This astronomer discussed how each planet of the solar system was like a different voice singing in a choir in his book *Harmonices Mundi*. This astronomer proposed a nested platonic solid model of the solar system. NASA’s major extrasolar planet hunting telescope is named after this astronomer, who used Tycho Brahe’s calculations to discover rules such as how solar system orbits are all ellipses. For the point, name this astronomer who developed three laws of planetary motion.

ANSWER: Johannes **Kepler**

25. A cycloaddition reaction that is the hallmark of click chemistry is catalyzed by this metal, which reversibly binds oxygen in hemocyanin. A red-colored compound containing this metal precipitates out of solution when reducing sugars are detected in Benedict’s test. Bronze is an alloy made of tin and this element. This element is the lightest one to borrow an electron from the 4s orbital in order to completely fill the 3d orbital. For the point, name this transition metal with symbol Cu.

ANSWER: **copper**

26. This type of rock covers about three-quarters of the Earth’s surface, but makes up less than 10 percent of the volume of the crust. Cross-bedding can occur in these types of rocks if deposition occurs along the angle of repose. Karst landscapes are created due to weathering of this type of rock, often the limestone type. Conglomerates and breccias are subtypes of these rocks with larger particles than sandstone. For the point, name this type of rock created by the cementing together of small particles of minerals or other rocks, often contrasted with igneous and metamorphic rocks.

ANSWER: **sedimentary** rocks

27. This disease often occurs in conjunction with *Aspergillus* fungal infections. Measuring immunoreactive trypsinogen levels screens for this disease in babies. The Shwachman-Diamond syndrome is differentiated from this disease through normal result in a sweat test, which reports chloride ion levels. Most males affected by this disease are infertile due to a congenital absence of the vas deferens. For the point, name this genetic disorder where mucus accumulates in the pancreas and lungs.

ANSWER: **cystic fibrosis** or **CF**

28. One story claims that this man's experimenting with a set of differently weighted blacksmith hammers allowed him to discover the basics of musical tuning. The Law of Cosines generalizes the most famous work of this thinker, whose followers found meaning in a 10-point diagram called a tetractys and claimed he discovered the Platonic solids. For the point, name this ancient Greek mathematician whose namesake formula concerns the side lengths of right triangles.

ANSWER: **Pythagoras** of Samos

29. Crocodile icefish are the only known vertebrates to lack this compound as adults. The giant tube worm uses this molecule to transport hydrogen sulfide. Disorders known as thalassemias result from the abnormal production of this molecule, which confers a survival advantage against a disease when exactly one defective gene for this molecule is possessed. Its "S" form is the cause of sickle-cell anemia. For the point, name this iron-rich protein in red blood cells that transports oxygen.

ANSWER: **hemoglobin** (or **Hb**)

30. This author of Dialogue Concerning Two Chief World Systems allegedly stamped the ground and retorted "and yet it moves" when convicted guilty by the Catholic church. An apocryphal experiment conducted by this man describes him dropping two spheres of different mass from the Tower of Pisa. The discoverer of four moons of Jupiter was, For the point, what 16th century Italian scientist who was put on trial for defending heliocentrism?

ANSWER: **Galileo** Galilei

Extra Tossup – ONLY READ IF A QUESTION IS BOTCHED!

31. The Sunyaev–Zel'dovich effect is relevant on the scale of these astronomical entities. The center of the Great Attractor is the "Norma" one of these entities. Fritz Zwicky's discovery of dark matter used observations from the "Coma" one of these entities. The nearby one of these entities named "Virgo" includes M87 and along with the local group, forms the local "super" one of these entities. For the point, name these collections of galaxies.

ANSWER: galaxy **cluster**