



## National Science Bee Prelims - Round 1

1. The Hansen parameters define this property in relation to intermolecular forces. Le Chatelier's principle dictates the direction a reaction will shift when an equilibrium constant related to this property is exceeded, according to the common ion effect. Water and ethanol are miscible because they have this property for all proportions. Ammonium ions and nitrate ions exhibit this property for ionic salts in water. For the point, name this property, the ability of one substance to dissolve another.

ANSWER: **solubility**

2. According to the book *The Right Stuff*, this man replaced Chalmers Goodlin, who demanded \$150,000 to attempt a feat that this man would later accomplish. This man, a World War II "ace in a day," only alerted his wife and fellow aviator Jack Ridley that he broke two ribs when thrown from a horse. That event occurred just days before this pilot used *Glamorous Glennis*, a Bell-X1 plane, to surpass 1 Mach. For the point, name this pilot, the first man to travel faster than the speed of sound.

ANSWER: Charles "Chuck" **Yeager**

3. Organic-rich black shale deposits have been correlated with the Toarcian Turnover, an extinction event during this period. The Solnhofen Limestone is home to fossilized creatures who lived in this period, including the earliest-known bird, the *Archaeopteryx*. During this period, much of western North America was covered by the Sundance Sea, whose receding led to the accumulation of the Morrison formation. For the point, what is this period between the Cretaceous and Triassic that was famed for its dinosaurs?

ANSWER: **Jurassic** period

4. A function has this property if the limit as you approach an  $x$  value equals the actual value of the function at that  $x$  value. The absolute value function has this property everywhere, despite not being differentiable at the sharp turn at the origin. Examples of locations where this property breaks are holes and asymptotes. For the point, name this property of functions whose graphs can be drawn without lifting the pen from the paper.

ANSWER: **continuity** (accept word forms like **continuous**)

5. This tissue can be reabsorbed by cells that reside in small depressions called Howship's lacunae. Hematopoiesis occurs in the cancellous type of this tissue, whose Volkmann's canals connect the periosteum with blood vessels of Haversian canals. This tissue, which replaces cartilage at the epiphyseal plate during growth, is made up of a mineralized matrix that includes hydroxyapatite and collagen. For the point, what connective tissue makes up the skeletal system and is weakened in osteoporosis?

ANSWER: **bone** tissue (or **osseous** tissue)

6. The first one of these objects discovered and also the closest to the Earth is 3C 273. One of these objects is seen four times because of gravitational lensing in the Einstein Cross. These objects are active galactic nuclei powered by accretion into their central supermassive black hole and come in "radio loud" and "radio quiet" variants. For the point, name these extragalactic objects whose name is a contraction of "quasi-stellar radio source".

ANSWER: **quasar** [accept **quasi-stellar radio source** or **quasi-stellar object** before mentioned]

7. A constant associated with this force was experimentally determined by Henry Cavendish. Describing this force in quantum mechanics is key to providing a theory of everything for the universe. In classical physics, this force for two objects is inversely proportional to the square of their separation distance and directly proportional to the product of their masses. For the point, name this weakest of the fundamental forces that at the earth's surface causes acceleration of 9.8 meters per second squared.

ANSWER: **gravity**

8. Griffin and Davies name different HLB methods for classifying these substances, whose pulmonary type is made up of DPPC and secreted by alveolar cells. Proteins can be denatured with SDS, one of these substances, which remain in their crystalline forms below the Krafft temperature. Surface tension of these substances steadies at the CMC, beyond which micelles form. For the point, name these substances that have hydrophobic heads and hydrophilic tails and are often used in detergents like soap.

ANSWER: **surfactants**

9. Framework regions of these molecules are more resistant to the hypersomatic mutations that affect their complementarity determining regions. The "12/23" rule is enforced when these molecules undergo VDJ recombination. Monoclonal types of these proteins bind to the same epitope. In class-switching, these proteins' heavy chains are changed so that their "M" or "D" types can become "G," "A," or "E" types. For the point, what Y-shaped proteins bind to antigens during the immune response?

ANSWER: **antibodies** (accept **antibody**, **immunoglobulins**, or **Ig**)

10. A theorem named for this type of number notes that the amount of these numbers less than a given value is roughly that value divided by the log of that value. The fundamental theorem of arithmetic notes that every natural number greater than 1 is either one of these numbers or can be expressed as a product of these numbers. For the point, name this class of numbers that cannot be evenly divided by whole numbers other than itself and 1.

ANSWER: **prime** numbers

11. The Angular framework helps this language through directives and expressions. This language is the main language whose functionality is increased through Cascading Style Sheets. Common Gateway Interface allows programming languages such as PHP and JavaScript to produce files in this non-programming language, which uses angled brackets to designate tags. For the point, name this markup language that forms the backbone of websites.

ANSWER: **HTML** [or **Hypertext Markup Language**]

12. The Nice model concerns the migration history of these objects. A 2016 paper led by astronomer Mike Brown hypothesized the existence of one of these objects. In 2006, the IAU stated that these objects must be nearly spherical in shape and also have "cleared their neighbourhood". Ancient Greek astronomers called these objects "wanderers". For the point, name this class of objects that, within our solar system, no longer includes Pluto.

ANSWER: **planets** [prompt on "gas giants"]

13. Differentiation of this material can occur through fractional crystallization, where this substance becomes more felsic in accordance with Bowen's reaction series. Flow banding results when viscous forms of this material come into contact with solid interfaces. Rhyolitic and andesitic types of this material have high silicon dioxide contents, while this substance's basaltic form has the fastest flow. For the point, name this molten rock that collects in namesake chambers beneath Earth's surface.

ANSWER: **magma** (do not accept or prompt on "lava")

14. In the Criegee mechanism, this compound interacts with an alkene to form two carbonyl groups. This compound is naturally destroyed by UV light rays, as described in the Chapman cycle. This compound can be made through the corona discharge method and is measured in Dobson units. The Montreal Protocol concerned this compound, which is destroyed by chlorine radicals. For the point, what compound has three oxygen atoms and makes up a namesake “layer” in the stratosphere?

ANSWER: **ozone** (or **trioxygen**)

15. The first Peano [[pee-ahn-o]] axiom is about the existence of this number. This value is the total length of the Cantor set. In the von Neumann [[noy-man]] ordinals, the empty set represents this number, and this integer represents false in Boolean algebra. This integer raised to its own power is often left undefined, but any other real number to this power gives a value of one. This integer is the additive identity. For the point, name this number that cannot be divided by.

ANSWER: **0**

16. This statement is modified by the acentric factor in the Soave-Redlich-Kwong equation. Maxwell’s equal area rule is used below critical temperatures to correct an equation that generalizes this law. In that equation about this law, the variable “a” accounts for intermolecular attractions. Corrected by the van der Waals equation, this law is most accurate at high temperatures and low pressures. For the point, rules named for Avogadro, Charles, and Boyle are combined in what law written  $PV$  equals  $nRT$ ?

ANSWER: **ideal gas law**

17. This particle’s “crisis” refers to its observed spin being different than its constituents. This particle, the primary material in cosmic rays, is the heaviest particle formed in Beta minus decay. This particle is composed of two up quarks and one down quark and is 1800 times heavier than its negative counterpart. The atomic number of an element is determined by the quantity of this particle. For the point, name this nucleon that has a positive charge.

ANSWER: **proton**

18. The term for these astronomical objects was coined by Charles Misner and John Wheeler. A Roman Ring is a collection of these objects that do not allow for time travel. One type of these objects is an Einstein-Rosen bridge. A link between a black hole and a white hole and create, for the point, what type of hypothetical object that can allow for faster than light travel by introducing a direct connection between two distant regions of the universe?

ANSWER: **wormhole**

19. The power radiated from a black body is proportional to this quantity raised to the fourth according to the Stefan-Boltzmann law. This quantity is plotted on the x-axis of an HR diagram. The efficiency of a Carnot engine is determined by this quantity’s value for the reservoirs. Two objects in a closed system will have the same value for this quantity if allowed to exchange heat. For the point, name this quantity measured in Kelvin, Celsius and Fahrenheit.

ANSWER: **temperature**

20. An enzyme named for these structures was discovered in *Tetrahymena*. When rich in guanine, these structures can form G-Quadruplexes, which can stabilize T-loops in these structures. These structures are thought to be a cause for cellular aging and cancer. The Hayflick limit is explained when these structures shorten after repeated DNA replication. In humans, these structures have a sequence of TTAGGG. For the point, name these structures that protect the ends of chromosomes.

ANSWER: **telomeres**

21. In a radiometric dating technique, this element's radioactive isotope-40 decays to produce argon gas. This element, which has a lilac flame test, is used along with nitrogen and phosphorus in three-component fertilizers. This element's concentration within cells is maintained by an enzyme that actively pumps this element into cells and sodium out of cells. For the point, name this alkali metal with atomic number 19 that is symbolized K.

ANSWER: **potassium** (accept **K** before read)

22. A sequence of numbers named for this thinker has terms equal to 1 more than a product of the smallest primes. This thinker showed that whenever a prime divides a product it must divide one of the factors in Proposition 30 of his Book 7. This man popularized the theorem that isosceles triangles have equal base angles, and he used five axioms to open the first textbook in geometry. For the point, name this ancient Greek mathematician who wrote The Elements.

ANSWER: **Euclid** of Alexandria

23. The lever rule can be applied to these structures to determine mole fractions. In these structures, the Clapeyron equation accounts for slopes of boundary lines, one of which is negative for water because water is more dense as a liquid than as a solid. The unit Kelvin is defined by water's triple point, which is displayed on these structures when three curved lines intersect. For the point, name these diagrams that display different physical states of substances at varying temperatures and pressures.

ANSWER: **phase diagrams**

24. Variation in this phenomenon defines the seasons along the intertropical convergence zone. Anabatic winds cause this phenomenon to be more common on the windward side of mountains. Virga is a type of this phenomenon in the atmosphere. Petrichor is the scent produced by this phenomenon on the soil or rocks. Particularly dangerous tornadoes may be "wrapped" by this phenomenon. For the point, name this atmospheric phenomenon which can result in flash flooding if too much of it happens in a short time period.

ANSWER: **rain** [accept **precipitation**]

25. Retinal cells work with a cluster of cells in the forebrain to help execute this process at night. Both restlessness and increased food take can occur before this process, where northerly winds can cause its namesake "fallout" along the Gulf Coast. While the "reverse" type of this process can affect juveniles, proper navigation during it involves Earth's magnetic field. This process is longest for the Arctic tern. For the point, flocks go south for the winter during what large-scale seasonal journey?

ANSWER: bird **migration**

26. This man and Nathan Rosen proposed a type of "bridge" that connects two points of space-time, paving the way for future wormhole theory. In 1905, he wrote a paper on Brownian motion and another on using "photons" to describe the photoelectric effect. A theory by this man predicts time dilation and length contraction at extremely large speeds and describes the curvature of spacetime. For the point, name this German physicist who revolutionized our understanding of gravity with his theory of relativity.

ANSWER: Albert **Einstein**

27. This is the most iron-rich object in the solar system. Unusually, this planet's year is almost exactly 1.5 times the length of its day. The planet Vulcan was hypothesized to account for orbital anomalies of this planet, which was later explained using Einstein's theory of general relativity. This planet has the highest difference of any planet between its average daytime and nighttime temperatures. For the point, name this first planet from the sun.

ANSWER: **Mercury**

28. Some types of these landforms are created by fault blocks, often in an alternating pattern with grabens. Other types are created in a process called folding, such as many of the oldest examples of this landform along the U.S. east coast. The geologic process of creating these landforms is known as orogeny. Melting rocks at a subduction zone can cause rising magma to create these landforms in a similar process to what happens at hotspots. For the point, name these landforms, notable and steeply defined summits usually within namesake “ranges.”

ANSWER: **mountains** [accept **horsts** until “folding”]

29. These structures are called sessile when they lack petioles. Midribs are the main vascular tissue bundles on these structures, whose vein patterns are generally “parallel” or “branched.” Palisade layers in these structures lie below waxy cuticles, which protect these structures from losing too much water through transpiration. Guard cells regulate the opening and closing of stoma in these structures. For the point, name these green structures, the site of photosynthesis in plants.

ANSWER: **leaves** (or **leaf**)

30. In neutral geometry, these objects cannot exist at the summit vertices of a Saccheri quadrilateral. Two vectors form this type of angle when their dot product is negative. In a triangle, the square of the side opposite this type of angle is larger than the sum of the squares of the other two sides. Two altitudes lie outside triangles with this type of angle. The larger angle in a supplementary pair is, for the point, what type of angle measuring more than 90 degrees?

ANSWER: **obtuse** angle

**Extra Tossup – ONLY READ IF A QUESTION IS BOTCHED!**

31. Important cell groups in this organ include the SA and AV nodes. This organ's function can be measured using an EKG. A cycle performed by this organ includes the diastole and the systole. Two atria and two ventricles make up, in humans, the four chambers of this organ. Severe chest pains can signal the onset of a so-called "attack" of this organ. For the point, name this organ that pumps blood around the body.

ANSWER: **heart**