SASS

Shreyas's All-Science Set

Written by:
Shreyas Vissapragada, Avik Laha, Ashwin Kannan, Baasit Jamal

Edited by:
Eric Mukherjee, Andrew Wang, Billy Busse, Nicholas Karas, Abid Haseeb

Round 1

1. The deflection of a cantilevered beam is directly proportional to the load and length, and inversely proportional to Young's modulus and this quantity. A difference of two of these quantities appears in Euler's equations of motion, and these quantities are coefficients in the definition of Poinsot's ellipsoid. If an object is deformed around its axis of rotation, then by the stretch rule, this quantity will not change. If an object is not rotating about its center of mass, this quantity can still easily be calculated with the addition of an mr^2 term by the parallel axis theorem. Name this quantity, equal to torque divided by angular acceleration, which is the rotational analogue of mass.
ANSWER: **moment of inertia** [do not accept or prompt on "inertia"] <SV>

2. One derivative of this vitamin is a cofactor in the enzyme complex mutated in Maple Syrup Urine Disease. One derivative of this vitamin called TPP helps catalyze the decarboxylation of pyruvate before it is transformed into acetyl-CoA. A deficiency of this vitamin in chronic alcoholics leads to Wernicke-Korsakoff syndrome. This vitamin plays a role in the biosynthesis of GABA, and along with Vitamin B_7, this is one of the only two sulfur-containing vitamins. This vitamin was first named aneurin because of the severe neurological effects when it was lacking in the diet. Because members of the Japenese navy ate a diet consisting of polished white rice, they were subject to the most notable form of this vitamin's deficiency. Name this B vitamin, whose deficiency causes beriberi.
ANSWER: **Vitamin B_1** [or **thiamin**e] <SV>

3. When performing this action on any two numbers a^2 and nb^2, the result is closed under multiplication by Brahmagupta's identity. The "general coproducts" in category theory are one of the most abstract generalizations of this and the "maximum operation" in set theory is a dequantized version of this. Integration over a zero-dimensional manifold reduces to this, and this operation is applied to each term of the Taylor polynomial for e^x. To apply this operation on two vectors, the "tail to tip" method can be used, and when this operation is applied to the terms of a sequence, it yields a series. Name this function, commonly denoted with a capital sigma or with the plus sign.
ANSWER: **addition** or **summation** [accept word forms] <AL>

4. The climate of this region is classified as Dfc, Dwc, and Dsc according to the Köppen classification system. Common plants from this biome include fireweed and lingonberries. Podzolization occurs when acids from evergreen tree needles seep into the soil, and because of their high resistance to cold, larch forests can often be found in large flat areas containing permafrost. This biome is also home to the muskeg, a type of bog that can be found in glacial depressions. Wapiti, grosbeak, and pine martins are common to these areas, and this makes up 29 percent of the world's forests. Name this largest land biome, also known as boreal forest.
ANSWER: **taiga** (accept boreal forest before read) <AK>

5. This functional group can be added to an alkene in a Markovnikov fashion by adding mercuric acetate and water, followed by sodium borohydride in a sodium hydroxide solution in a process called oxymercuration. When compounds containing this functional group are of low mass, zinc chloride can be used to classify them in the Lucas test. Secondary ones can be oxidized into ketones, and when yeast cells undergo fermentation, they produce carbon dioxide and a compound which contains this functional group. Name this functional group with general formula R-OH, examples of which include ethanol and methanol.
ANSWER: **alcohol** [or **hydroxyl**] <BJ>

6. The square root of electron density times charge squared over mass times the permittivity constant gives the frequency of oscillation in this substance. One equation dealing with this substance relates temperature and density to ionization state; that is the Saha equation. The pinch effect often takes place in this kind of substance. Debye screening prevents electric fields from affecting substances in this state at large distances. The coronal heating problem may exist because Alfven waves change into other waves in this substance in the sun. It can be measured by a Langmuir probe. Name this type of matter found in the ionosphere which is notably not gaseous, liquid, or solid.
ANSWER: **plasma** <SV>

7. The nearest group of galaxies to it is the IC342/Maffei Group, which may have been ejected from it during their early formation. One candidate for a dark galaxy within it includes Smith's Cloud, while the Monoceros Ring is a ring of stars within it. The membership of NGC 3109 is questionable due to its distance from the center of this entity, while the only unbarred spiral galaxy within it is the Triangulum Galaxy. The largest galaxy in it is the Andromeda Galaxy, with around a trillion stars, though Andromeda might not be the most massive. Name this group of galaxies which includes the Milky Way.
ANSWER: **Local Group** <AL>

8. According to Cretekos et. al., a bat-specific prx1 enhancer region could be the reason these structures exist in bats. A samara is a type of seed which has these. A controversial study by Nudds and Dyke in 2010 posited that *A. lithographica* could not fully use these structures. After metamorphosis, butterflies must engorge these with hemolymph. Dragonflies are one of only insects to have muscles directly powering these structures. Convergent evolution explains the presence of these structures in both insects and bats, in which these structures are homologous to bones in the limbs of other mammals. Name this appendage, commonly possessed by birds and other animals that can fly.
ANSWER**: wing**s <BJ>

9. This results from phonon interactions in simple metals. Joule heating is caused by this, while Wheatstone bridges are used to find unknown values for this quantity. The thermal form of this quantity is equal to the length of the material over the conductivity times the cross-sectional area. "Drug" this occurs when pathogens become able to survive exposure to certain drugs, rendering those drugs obsolete. Drag is sometimes called this of air. Name this term, the electrical type of which measures of the degree an object opposes the flow of an electrical current, measured in ohms.
ANSWER: **resistance** <AL>

10. The type of these highest in the atmosphere appears to be increasing in frequency, brightness, and extent, which is believed to be linked to climate change. Those are the noctilucent variety. The nacreous variety has been implicated in the creation of ozone holes due to their disruption of the nitrogen and chlorine cycles. Adiabatic cooling is one of the main agents of the formation of these. Jean-Baptiste Lamarck's system of categorizing these was unpopular because it employed unusual French names. Overshooting tops are present in powerful ones, while contrails are artificial ones. Identify these masses of droplets or crystals suspended above a planet's surface.
ANSWER: **cloud**s <AL>

11. Two methods of determining these entities are the nudged elastic band and string methods. One theory of them states that on the potential energy surface of a reaction, they occur at each saddle point. They are referenced using double-dagger notation in the Eyring-Polanyi equation, which describes them. They most closely resemble the reaction species to which they are closer in free energy according to the Hammond postulate. Enzymes work by making these entities more stable. Name these excited states represented by the peaks in a reaction coordinate, forming part of the activated complex.
ANSWER: **transition state**s [accept **activated complex** until mentioned] <BJ>

12. In a Karnaugh table, these laws are used to calculate the product of sums. These are also used in digital logic gates to show that only half of the $2*2^n$ possibilities are unique, where n is the number of logic gates. These laws are used to express conjunctions in terms of disjunctions and vice-versa via negation. Proved through truth tables, this set of laws was named after a Madurai-born British mathematician. Name these laws from Boolean algebra and propositional logic that state that not parenthesis p and q close parenthesis equals not p or not q.
ANSWER: **De Morgan's Laws** <AK>

13. Roberson, Sanders, Seymour, and Thomas proved this statement by showing that every snark has the Petersen graph as a minor. This was first proposed by Francis Guthrie in 1852, and Kempe and Tait's purported proofs for this were later shown to be incorrect after being unchallenged for eleven years. Appel and Haken's proof of this theorem involved 1936 configurations. This was the first major theorem to be proved using a computer. Name this theorem which states that no more than the eponymous number of colors is needed to color a map so no adjacent regions are the same color.
ANSWER: **Four-Color** Map **Theorem** <AL>

14. The Laplacian of an electric potential field is equal to the negative free charge density over this quantity. This quantity is equal to the negative time derivative of the magnetic flux, and in an inductor, it is equivalent to the inductance multiplied by the negative time derivative of the current. It is classically defined as Coulomb's constant multiplied by the sum of charge over distance, and also as the line integral of the electric field "dot dl." When it is multiplied by current, it gives power dissipated by a resistor. Kirchoff's Loop Rule states that the sum of this value around a loop in a circuit is zero. Name this quantity this is equal to the current times resistance by Ohm's Law.
ANSWER: **voltage** [accept **electric potential** difference, **emf**, and **electromotive force**, do not accept anything having to do with potential energy] <SV>

15. This man related radiative forcing to the natural log of a ratio of carbon dioxide concentrations in his namesake greenhouse law. He originated the idea that life was carried between planets by spores, which is called panspermia. Inverse temperature can be found on the x-axis of one of his namesake plots. The Eyring-Polyani equation is closely related to an equation named for this man, which relates the rate constant of a reaction to a pre-exponential factor and activation energy. Name this man who created an acid-base theory that states that bases dissociate in solution to form hydroxide ions.
Answer: Svante **Arrhenius** <BJ>

16. Leonardo da Vinci first recognized the 2/5 arrangement of leaves; that arrangement possesses this property. Two special forms of this happen when an organism repeats one part either four or five times; those are called tetramerism and pentamerism. This property is usually prevalent in animals that are either slow-moving or entirely sessile, and some phyla exhibit this feature only upon maturity, such as Echinodermata. Name this type of symmetry in which an organism is roughly similar through planes cut through it, contrasted with bilateral symmetry.
ANSWER: **radial** symmetry <BJ>

17. Ikaite is a crystal of this compund. This has begun to replace kaolin in the manufacture of glossy paper in North America. It is the primary component in travertine and Tums antacid, while vaterite and aragonite are both completely composed of this compound. Eggshells, as well as the shells of marine organisms and snails, are made of this substance. Combating acidification of soil and water with this compound is known as "liming". Identify this chemical compound, sometimes called calcite, with formula $CaCO_3$.
ANSWER: **calcium carbonate** [accept **$CaCO_3$** before mentioned] <AL>

18. This equation is used to derive the values for the y-axis of a Pourbaix diagram. One generalization of this equation uses a coefficient of 61.5 when assuming a body temperature of 37 °C, and another generalization simplifies to the Tafel equation at a high overpotential; those equations are Goldman and Butler-Volmer equations. At STP, this equation can be approximated using a coefficient of 0.059 volts. This equation states that the standard voltage minus RT over nF times the reaction quotient equals the new voltage. Name this equation which gives the potential of an electrochemical cell.
ANSWER: **Nernst** equation <BJ>

19. It's not the scaling parameter or the speed of light, but one parameter named for this man is squared in a non-relativistic version of Friedmann's equation. One system he helped create was modified by Gerard du Vaucouleurs to account for rings and lenses. That system classifies galaxies based on bars and spiral arms, and is known as his namesake tuning fork diagram. The constant of proportionality between distance and recessional velocity is termed his namesake constant. He is notable for proving the expansion of the Universe. Name this man who is the namesake of an optical space telescope.
ANSWER: Edwin **Hubble** <AK>

20. Dendritic cells use this to elaborate a specific immune response, while Ilya Mechnikov revealed this process in 1882, which played a large role in his winning of the Nobel Prize. *Trichoplax adhaerens* is the only multicellular organism to use this process for feeding. When this process is impaired, autoimmune diseases may occur due to apoptotic cell remnants. Hydrogen ion transport acidifies the lysosome after a vacuole is created in this process, so as to digest that vacuole's contents. Name this process in which a cell envelops a particle with its pseudopodia to form an interior phagosome.
AN SWER: **phagocytosis** <AL>