

Round 4

1. A di-iodo derivative of this compound is reacted with a zinc-copper couple and cyclohexane to yield a cyclopropane in the Simmons-Smith reaction. This molecule can be produced from olivine along with serpentine and magnetite in a specific serpentinization reaction. Aluminum carbide reacts with water to form this compound. This gas produces the most heat per mass unit of any hydrocarbon. This compound is being released in the Arctic as permafrost thaws. Cows release around 100 kilograms of this compound per year through flatulence. Name this simplest alkane, with formula  $\text{CH}_4$ , that is notorious for its odor.

ANSWER: methane [accept  $\text{CH}_4$  until mention] <BJ>

2. This color names a programming language which was used to teach object-oriented programming, though development of the language was stopped after one of its developers began working on a successor to teach Java. Lasers of this color became widely available to the public in 2010. Cobalt is used to make glass of this color. In the Doppler Effect, the spectrum of a wave is said to be shifting towards this color if that object is approaching the observer. A computer named after the “deep” shade of this color defeated Garry Kasparov. Identify this color between indigo and green on the optical spectrum, the B in ROY G BIV.

ANSWER: blue <AL>

3. In 2009, it was found that sufferers of Gaucher’s disease had a higher risk for this disease because of mutations in GBA. Selegiline is one drug used to treat this disease, and it functions as an MAO-B inhibitor. In this disease, ubiquitin forms complexes with alpha-synuclein, leading to Lewy body formation in the substantia nigra. William Knowles and Arvid Carlsson both won Nobel Prizes for their work on a treatment for this disease that can cross the blood-brain barrier, called L-DOPA. Name this disease, with symptoms such as shaking, rigidity, and slowness of movement, which is caused by a lack of dopamine in the brain.

ANSWER: Parkinson’s disease [or PD] <SV>

4. The varieties of this quantity named for Shannon and Hartley can be generalized by the version named for Renyi. For all liquids, the change in this quantity is about the same according to Trouton’s rule. For an ideal gas, this quantity can be calculated with the Sackur-Tetrode equation. A definition of this quantity is the logarithm of the number of microstates corresponding to a particular macrostate multiplied by Boltzmann’s constant. A consequence of Maxwell’s Demon would be the reduction of this quantity, violating the 2<sup>nd</sup> Law of Thermodynamics. Name this state function represented S, sometimes described as the disorder of a system.

ANSWER: entropy <BJ>

5. The diameter of this object was discovered in 1959 by Robert Brown and Richard Twiss with a stellar intensity interferometer. Ejnar Hertzsprung suggested that this object was a member of the Ursa Major Moving Group, and Friedrich Bessel observed the inconsistencies in this object’s orbit that led to the discovery of its companion star by Alvan Clark. Along with Procyon and Betelgeuse, this star makes up the Winter Triangle. This star’s companion was the second white dwarf to be discovered. Ancient Egyptians associated the seasonal flooding of the Nile with this star. Name this brightest star in Canis Major and in the night sky, sometimes called the “Dog Star.”

ANSWER: Sirius A <AK>

6. The Tschirnhausen cubic catacaustic is a semicubical example of this figure, and a segment of one of these is a Lissajous curve. Menaechmus studied these, which were given their current name by Apollonius, in an attempt to achieve cube duplication. Their surface of revolution is used for car headlights as they have the property that all light originating at their focus will be reflected parallel to their axis of symmetry. All of these have an eccentricity of one, and are thus similar. This figure is created by slicing a cone on a plane parallel to a straight line along its surface. Identify this conic section, defined by a focus and directrix, an example of which is the graph of  $y = x^2$ .

ANSWER: parabola [prompt on “conic section” before mentioned] <AL>

7. The M/D/1 type of these was solved by Agner Erlang in 1917. The stationary distribution of the M/G/1 type, whose arrivals are modeled by a Poisson process, can be computed using Ramaswami's formula. Kendall's notation is used to describe them, and in the theory of these objects, many theorems can be proved by simplifying these to Markov chains. The most common operations on these structures act only on the front and rear terminal positions, and these can serve the purpose of a data buffer. A double-ended one of these is known as a deque (DECK). Name these first-in-first-out linear data structures that can be modeled by people waiting in a line.

ANSWER: queues <AK>

8. When solutions are found to Laplace's equation, the angular portion of the solutions is a set of harmonics named for this. This type of aberration is inversely proportional to the third power of focal length. Lunar orbits are stable in the Hill version of this. The efficiency of packing these to be at around 74% by Kepler's Conjecture. For a perfect one of these, Stokes' Law gives the drag to be  $6\pi$  times the viscosity times the radius times the velocity. The total energy for a rolling one of these is  $(7/10)mr^2$ , and the moment of inertia for one of these is  $(2/5)mr^2$ . Name this shape that is the three-dimensional analogue of a circle.

ANSWER: sphere <SV>

9. The curved line in a de Finetti diagram can be used to display this condition. This condition is used as the null hypothesis in Tajima's D test. Fisher's exact test can also be used to determine whether or not this state is actually true given a population's genotypic ratios. A lack of migration, diploidy, and an infinitely large population size are among the seven assumptions that must be fulfilled for this condition to occur. Of the two equations that govern this state, one equation describes genotypic frequency, while the other describes phenotypic frequency. Those two equations are  $p + q = 1$  and  $p^2 + 2pq + q^2 = 1$ . Name this idealized state in which evolution does not occur.

ANSWER: Hardy-Weinberg equilibrium [accept equivalents for "equilibrium" like "model" or "law"] <BJ>

10. During World War I, this chemist organized mobile x-ray units for the military. When boron and aluminum are bombarded with alpha particles, a process discovered by this chemist's daughter takes place; that process is the artificial variety of a process this chemist is famous for. This chemist used an electrometer to measure the currents produced by uranium. This chemist frequently worked with materials like torbernite and pitchblende. This chemist won a Nobel Prize in both Physics and Chemistry, and she died because of her long-term exposure to radiation. Name this female Chemist from Poland who worked with elements such as polonium and radium.

Answer: Marie Curie <BJ>

11. The polarization type of this quantity is proportional to the average electric dipole moment. The electric field times the electrical conductivity yields the "current" form of this quantity, which is also given as current over cross-sectional area. One type of this quantity is a useful tool for comparing the efficiencies of fuels; that energy variety of this quantity is equal to useful energy divided by volume. Specific gravity relates this quantity between two substances. Name this quantity, which, in its simplest form, is stated as mass over volume.

ANSWER: density <SV>

12. Some methanogens in the domain Archaea contain pseudomurein in this organelle. This organelle is composed of biogenic silica in diatoms; in that case it can be called a frustule. Some fungi contain these organelles composed of zymosan, mannoproteins, and chitin. Gram staining in bacterial cells can group cells based on the presence of peptidoglycan in this organelle. In plants, the pectin-rich space between these organelles is called the middle lamella. It is responsible for maintaining turgor pressure in plants, and it is typically made of cellulose. Name this organelle, a rigid outer layer that is notably absent in animal cells.

ANSWER: cell wall [do not accept or prompt on "cell membrane"] <SV>

13. One of these numbers equal to the geometric mean of the coefficients of the continued fraction expansion of  $x$  is named for Alexander Khinchin. The Loschmidt one of these is used in the definition of a unit of number density named after Emile Amagat. The Hartree energy is one used in computational chemistry and physics, and one of these created by Einstein was considered his “great blunder;” that was his cosmological one. Pressure times volume equals number of moles times temperature times the ideal gas type of this. Name these unchanging numbers in science, exemplified by the extremely large one named for Avogadro.

ANSWER: constants <AK>

14. Compounds that cause an effect that facilitates this could be released as a result of the clathrate-gun hypothesis. The parameters of an ideal model of this effect are represented by epsilon and alpha-sub-p, and ocean acidification is another accelerating mechanism that contributes to this. Future geoengineering and adaptation are two proposed responses to this, and ozone is a gas that contributes to this phenomenon. For climate to adjust to changes in external forcings, a large amount of time is required, due to the thermal inertia of the oceans. Name this phenomenon, the rise in Earth’s average temperature.

ANSWER: global warming <AK>

15. Viete’s formula can be used to compute this using an infinite product, and the Euler-Poisson integral is equal to the square root of this. The Riemann zeta function evaluated at  $s=2$  is equal to this quantity squared over six. Barbier’s theorem states that every curve of constant width has a perimeter this many times its width. The Chudnovsky algorithm was used in calculations of this to 10 trillion digits. The Buffon needle is notable for being able to approximate this, and  $e$  to the power of  $i$  times this number is negative 1. Name this transcendental number, often approximated 3.14, which is used in finding the area of a circle.

ANSWER: pi [accept 2/pi before “infinite product”] <AL>

16. This man invented a primitive form of roulette in his goal to develop a perpetual motion machine. His namesake geometric theorem involves a hexagon inscribed in a conic section, whose opposite sides can be used to derive a special line. In fluid mechanics, a principle named for him allows people to break the bottom of a bottle by hitting the top; that principle states that pressure will be transmitted throughout an enclosed, static fluid. A wager named for this man, although philosophical, contributed to probability theory. Identify this French mathematician whose namesake triangle lists off binomial coefficients where each row corresponds to a different power.

ANSWER: Blaise Pascal <AK>

17. The evolution of this construct is sometimes cited as a cause of the Cambrian explosion. Because of their toughness, these constructs are often used paleontologically to examine animals. Ecdysis occurs when an animal sheds one of these, which allow it to grow. All arthropods possess one of these. However, some animals, such as clams, have no need to do so—they simply add new material to the old one. Name this hard, external covering that is composed of chitin and can be strengthened with calcium carbonate, sometimes contrasted with endoskeletons.

ANSWER: exoskeleton <BJ>

18. The Lie group that most accurately describes isometries in this theory is the Poincare group. One experiment in this theory shortened one arm on an interferometer and is named for Kennedy and Thorndike. When the Schrodinger equation is corrected for this, it becomes the Klein-Gordon equation. The diagram that uses hyperbolas and light cones to show this theory and the space in which this theory takes place are both named for Minkowski. Events in this theory are four-vectors, and one quantity that appears in this theory is represented with a gamma and called the Lorentz factor. Name this theory which explains phenomena like time dilation and length contraction.

ANSWER: special relativity [prompt on “relativity,” do not accept or prompt “general relativity”] <SV>

19. Tavurvur is one of these located near Rabaul in Papua New Guinea. Commonly found near subduction zones, these form chains along boundaries between tectonic plates where oceanic crust is forced underneath continental crust. Characterized by explosive eruptions and consisting of layers of tephra, pumice, and rhyolite, the collapse of these features can result in the formation of calderas. These geologic features exhibit pyroclastic flows composed of volcanic fragments and gases, and these are also polygenetic and have multiple eruptions. Name this type of volcano, also known as a composite volcano, one of which buried the town of Pompeii in 79 AD.

ANSWER: stratovolcanoes <AK>

20. Perath and Flodin introduced the use of dextran gels in one form of this process. Another form of this process can be coupled with the Snyder index, which describes the polarity of some compounds. Resolving power is related to the kinetic parameters of this process in the Van Deemter equation. Sepharose beads are used in the size exclusion form of this process, another form of which utilizes a silica-packed column. An R<sub>f</sub> value is determined following the capillary-action driven movement of the mobile phase across the stationary phase in the thin-layer form of this technique. Name this separatory lab technique whose name means "color-writing."

ANSWER: chromatography [accept specific forms of chromatography, like size exclusion chromatography, thin-layer chromatography, gas-liquid chromatography, and high-performance liquid chromatography]