Round 6

Regulation

(Tossup 1) A displacement form of this quantity was introduced by James Clerk Maxwell as a modification to Ampere's Law. An enclosed circulation of a non-zero amount of this quantity forms a magnetic dipole. Electrical engineers represent the imaginary constant with j instead of i because i is already used for this quantity. This quantity is equal to voltage over resistance, according to Ohm's Law. For the point, name this quantity reported in amperes, a measure of how fast charge carriers flow through a circuit.

ANSWER: **current** (or displacement **current**)

(Tossup 2) Cockcroft and Walton used one of these devices to achieve the feat that led to their 1951 Nobel Prize in Physics. Ion implanters used to dope silicon for use in electronics are a type of this device which can cause sputtering. The D-shaped electrodes in one of these devices cause a spiraling pattern to emerge, leading to the name cyclotron for that generation of these devices. For the point, name these devices which may use electric fields to speed up beams of protons.

ANSWER: **particle accelerator**s (accept particle **collider**s)

(Tossup 3) Francois Jacob and Jacques Monod studied this organism and discovered it produces a permease and cleaving enzyme that help metabolism when glucose levels are low. Negative repressible feedback mechanisms have been found in this organism's trp ["trip"] and lac operons. This bacteria produces a Shiga toxin associated with haemolytic uremic syndrome, in its most clinically significant serotype O157:H7. For the point, name this rod-shaped bacteria present in the gut whose toxic outbreaks have been linked to romaine lettuce.

ANSWER: **E**scherichia **coli** (prompt on "coli")

(Tossup 4) This equation can be used to plot a Pourbaix [por-bay] diagram. In biology when modelling a cell membrane, the Goldman equation replaces this equation to take into account multiple ions. This equation features the term: negative R, T over z, F times the natural log of Q, where Q is the reaction quotient, F is the Faraday constant, and z is the number of electrons transferred in the cell reaction. A galvanic cell's reduction potential is given by, for the point, what electrochemical equation named for a German chemist?

ANSWER: **Nernst** equation

(Tossup 5) Firn is a substance found at the head of one of these bodies, made of compacted névé [nay-vay]. Cirques [serks] are created by the action of these bodies, and seracs [suh-ROCKS] are formed when two or more crevasses [kruh-VOSS-es] meet on one of these bodies. Randklufts and bergschrunds can be found where these bodies begin to pull away from stable rocky cliffs. Moulins ["Mulans"] allow water to enter these bodies from the top. For the point, name these bodies that contain most of Earth's fresh water in the form of dense, moving ice.

ANSWER: **glacier**s

(Tossup 6)   Two candidates for this substance are termed WIMPs and MACHOs, neither of which is composed of baryons. A model of cosmology using a lambda parameter describes this substance as "cold." Vera Rubin provided evidence for this substance by showing measurements of angular motion of galaxies did not fit predictions, suggesting some missing form of matter. For the point, name this probable form of matter making up most of the universe, named for the fact that we cannot detect it with light.

ANSWER: **dark matter** (accept just **dark** after matter; accept **cold dark matter**)

(Tossup 7)   In the early 20th century, only scientists from this country could detect the fictitious N-rays. Hand and face transplants were both first carried out in this country. The HIV virus was discovered by researchers in this country at an institute named for the developer of the first successful anthrax vaccine. The metric system was invented during this country's revolution, and the element gallium is named for it. For the point, identify this country whose eminent scientists include Louis Pasteur, Henri Becquerel, and Pierre Curie.

ANSWER: **France**

(Tossup 8)   The "num" library in this language is used for mathematical algorithms and data statistics. Tutorials in this language commonly make use of "spam" and "eggs" as variable names. This language, developed by Guido van Rossum, is typically recommended for novices due to its lack of syntactic overhang, since it delimits blocks with whitespace indentation. For the point, name this interpreter language that is actually named after a British sketch comedy show and not a snake.

ANSWER: **Python** (accept **Num**Py [num-PIE])

(Tossup 9)   Pannus, or scud clouds, may appear underneath this type of cloud. Arcus clouds serve as accessories to this type of cloud. These clouds form as convection continues to expand a congestus cloud, where wind shear near the tropopause can give them their characteristic anvil-like tops. The maximum parcel level is reached in some of these types of clouds, creating a dome-like "overshooting top." For the point, name these large and menacing clouds that may develop into thunderstorms.

ANSWER: **cumulonimbus** clouds

(Tossup 10)   The only known car in space is this color and is a Tesla launched on SpaceX's Falcon Heavy in 2018. Stars which have depleted hydrogen in their cores but are still fusing it in a surrounding shell are known as this color of giants. An increase in wavelength as objects move further from the observer is known as this color shift. A high-pressure storm in the atmosphere of Jupiter is named for being a "Great Spot" of this color. For the point, name this color usually associated with the planet Mars.

ANSWER: **red**

(Tossup 11)   Pickwickian syndrome is an obesity-associated disorder of this body system, which can also suffer a namesake distress syndrome when surfactant is lacking. This body system's tidal volume is normally about 7 milliliters per kilogram of body weight, but that number may be reduced by emphysema. In most aquatic animals, gills are the major organs of this system. Alveoli are the functional units of, for the point, which body system that exchanges carbon dioxide for oxygen in the lungs?

ANSWER: **respiratory** system

(Tossup 12) To directly detect the gravitational form of this phenomenon, the Hafele-Keating experiment team flew in commercial airliners while measuring cesium beams. The anomalous half-life of muons was explained by this phenomenon. The Lorentz transformation implies relativity of simultaneity, length contraction and this phenomenon. If Rita travels at 99.9% the speed of light to Alpha-Centauri and back, her twin Anna would be older than her as a result of this phenomenon. For the point, name this consequence of special relativity where time slows down.

ANSWER: **time dilation** (prompt on "special relativity" until mentioned)

(Tossup 13) Fyodorov proved that a type of this structure with translational symmetry has only 17 possible different patterns called wallpaper groups. The Conway criterion describes whether a certain prototile can create one of these structures. Rep-tiles can be used to create a pinwheel, which is an aperiodic type of this structure. Only three shapes can create the regular type of these structures: triangles, squares, and hexagons. For the point, name these structures, sometimes called tilings, which cover the surface of a plane with a pattern of repeated smaller shapes.

ANSWER: **tessellation**s (accept **tiling**s until "prototile")

(Tossup 14) In 1927, this journal published the result of the Davisson-Germer experiment which supported wave-particle duality. Its annual list of 10 "people who mattered" in science recently included Scott Pruitt. This British journal famously published Watson and Crick's paper on the structure of DNA without sending it out for peer review. For the point, name this prestigious scientific publication currently owned by Springer whose single word name comes from a quote by William Wordsworth.

ANSWER: ***Nature***

(Tossup 15) Soft-bodied organisms from this geological period are preserved in the Chengjiang biota. Stephen Jay Gould's book *Wonderful Life* describes unusual fossils from this period such as the five-eyed *Opabinia* and the dominant predator *Anomalocaris*. *Pikaia*, the possible ancestor of all vertebrates, first appears in rocks of this period's Burgess Shale. Famous for its trilobites, for the point, name this geological period, the first in the Paleozoic era, that saw a namesake "explosion" in animal diversity.

ANSWER: **Cambrian** period

(Tossup 16) The development of this structure is divided into placode, bud, cap, and bell stages. Gutta-percha is an inert polymer commonly used to fill the base of these structures after pulp infection. The roots of these structures are covered with cementum, primarily made up of hydroxyapatite and collagen. These structures are embedded within the maxilla and mandible. For the point, name these calcium-rich structures such as the bicuspid and molar, responsible for breaking up food.

ANSWER: (human) **teeth** (or **tooth**)

(Tossup 17) Francis Wenham's invention of this device allowed him to see that long and narrow objects performed better. The Reynolds number was discovered in one of these devices by experiments on a scale model. Pressure-sensitive paint is sometimes used during testing in these devices and can help users of these devices perform a wake survey to determine drag. For the point, name these devices used to study the aerodynamics of objects by placing them in a tube with flowing air.

ANSWER: **wind tunnel**s

(Tossup 18)   This adjective names an isotope effect used to study reaction mechanisms in organic chemistry. Another branch of chemistry named with this term uses first and second order rate laws to classify reactions. A theory of gases described by this adjective assumes particles have negligible size, completely elastic collisions, and constant motion. For the point, name this adjective that labels a type of energy proportional to the temperature of a gas, in contrast to the potential energy.

ANSWER: **kinetic**s

(Tossup 19) Bubble chambers most frequently make use of this element's liquid form. Schrodinger was able to explain the Stark effect components of this element by using his namesake equation to solve it as a quantum system. To explain the Paschen, Balmer, and Lyman series that can be viewed from this element's emission spectra, Rydberg developed his namesake formula. Rydberg's formula was based on a planetary model developed by Niels Bohr of this element. For the point, name this element, described in quantum mechanics as a single proton orbited by a single electron.

ANSWER: **hydrogen** (accept liquid **hydrogen** or **H2**; accept **hydrogen** gas)

(Tossup 20) These objects decay by emitting Hawking radiation, and active galactic nuclei are powered by accretion of gas into these objects. An image of one of these objects at the center of M87 was taken by a global array of radio telescopes known as the Event Horizon Telescope in 2019. Their Schwarzschild radius is where the escape velocity equals the speed of light. For the point, name these astronomical objects that are so massive that not even light can escape their gravitational pull.

ANSWER: **black hole**s

(Tossup 21) Natick Labs is a part of this organization which recently developed the OCP as a replacement for UCP and MultiCam. The eCybermission competition is run by this organization as part of their STEM outreach program. The Corps of Engineers is a branch of this organization known for their work in flood control. This organization commissioned the Apache helicopter and the Humvee, both of which today often feature its single-star logo. For the point, name this military organization which trains its cadets at West Point.

ANSWER: **U**nited **S**tates **Army** (prompt on just "Army")

(Tossup 22) To measure the contribution of time dilation to this effect observed in light, Ives and Stillwell set up an experiment using canal-ray tubes. In general relativity, this effect explains a cosmological effect described by Hubble's law. This effect, named for a Austrian physicist, was first hypothesized viewing binary stars and the color they emit. For the point, name this effect where an observer records a different frequency because the emitter is moving, best exemplified by a car driving past a stationary pedestrian.

ANSWER: **Doppler** effect (accept **Doppler** shift; prompt on redshift or blueshift)

(Tossup 23) Proteins are taken out of one of these materials and put onto a nitrocellulose membrane during a Western blot. Sodium dodecyl [do-dek-al] sulfate is commonly used in one of these materials to isolate proteins. Polyacrylamide, silica, and agarose are commonly used in these materials. These colloids are typically liquids dispersed in a solid medium. Larger macromolecules takes longer to run through these materials than smaller macromolecules. For the point, name these materials used in an electrophoresis technique that separates DNA.

ANSWER: **gel**s

(Tossup 24) In one form of this technique, a reagent containing alcohol, a base, sulfur dioxide and iodine is used to determine water concentration; that form of this technique is named for Karl Fischer. Iodine is treated with a starch to form iodide in one redox variant of this technique. Diprotic acids have two inflection points on a namesake curve in the acid-base variety of this technique. Indicators used in this technique include methyl orange and phenolphthalein [fee - nul - thay - leen]. For the point, name this technique of determining an unknown concentration from a known one.

ANSWER: **titration** (accept **titrimetry**; accept **volumetric analysis**)

(Tossup 25) Hiram Moore's 1834 version of this machine needed to be pulled by an animal team, and a later development saw the use of a steam engine powered by burning the straw leftover by the use of this machine. Such straw was often pulverized by the rotary version of these devices, such as the Axial Flow model from International Harvester. The grain platform can be changed to a more specialized header in these machines to cut crops such as wheat and corn. For the point, name this agricultural machine that winnows, threshes, and reaps, all in one pass through a field.

ANSWER: **combine** harvester

(Tossup 26) These statements were refined by the measurements of Tycho Brahe [tike-oh bra-hee]. The second of these statements can be derived by conservation of angular momentum. The third of these statements, published ten years later, sets the square of the orbital period directly proportional to the the cube of the semi-major axis. The first of these laws states that all planets move around in ellipses with the sun as one focus. For the point, name these laws of planetary motion put forward by a contemporary of Copernicus.

ANSWER: **Kepler**'s three **laws** of planetary motion (accept **Kepler** after "laws" is read; prompt on "laws of planetary motion" by asking "As stated by whom?")

(Tossup 27)　A form of this quantity due to electromagnetic radiation can be calculated by dividing the time-averaged Poynting vector by the speed of light. This quantity is equalized throughout an incompressible fluid by Pascal's principle. This quantity remains constant in an isobaric process. This quantity is proportional to temperature according to Gay-Lussac's law, and proportional to volume according to Boyle's law. For the point, name this quantity, a measure of force per area, typically reported in torr or pascals.

ANSWER: **pressure** (accept radiation **pressure**)

(Tossup 28)　This scientist correctly predicted the landing site of the Treysa meteorite. Together with his father-in-law Wladimir Köppen, he wrote *The Climates of the Geological Past*, published in 1924. Six years later, this scientist died on an expedition to establish meteorological monitoring stations in Greenland. His best known contribution to science was published in his *The Origins of Continents and Oceans*. For the point, name this German scientist who proposed the theory of continental drift.

ANSWER: Alfred Lothar **Wegener** ["vague"-ner]

(Tossup 29)　MES, ADA, and Bicine are three examples of these systems that meet Norman Good's selection criteria. Carbonic acid in the blood serves as one of these systems. The pH of these systems can be calculated with the Henderson-Hasselbalch equation. These systems are commonly made by mixing a weak acid and conjugate base. They typically have a pKa within the range of 6 to 8. For the point, name these compounds that resist changes in pH.

ANSWER: **buffer**s (or **buffer** solutions; or **buffer** agents; **buffer** systems)

(Tossup 30)　For two coprime positive integers "a" and "n," "a" raised to the totient function of "n" is related to 1 times this operation on "n" according to Euler's totient theorem. Similarly, an integer "a" raised to some prime "p" is related to "a" with respect to this operation on "p" by Fermat's little theorem. This operation is the subject of the Chinese remainder theorem. The system of arithmetic based on this operation uses congruence relations to compare integers. For the point, name this operation, which "wraps around" and finds the remainder after division of one number by another.

ANSWER: **modulus** (accept **modular** arithmetic; accept **modulo** operation; prompt on mod; prompt on remainder)

Backup

(Tossup 31)　An estuary may form when one of these things meets a body of salt water. Biomes near these things are part of the riparian zone, and these things are the origin of oxbow lakes. The triangular-shaped mouths of some of these things are called deltas. Alluvial aquifers typically form next to these things and are built when these things deposit gravel and sand near their banks. For the point, name these moving courses of freshwater, such as the Mississippi and the Nile.

ANSWER: **river**s (accept synonyms such as **stream**s or **creek**s)

(Tossup 32)　The flux of this quantity is related to conductivity by Fourier's Law. The fluctuation-dissipation theorem explains why Johnson-Nyquist noise is related to generation of this quantity in resistors. This quantity remains zero in an adiabatic process. In thermodynamics, this quantity is symbolized Q and has units of joules. This quantity is commonly transferred via conduction, convection, or radiation. For the point, name this quantity, the amount of energy transferred along a temperature gradient.

ANSWER: **heat** (accept resistive **heating** or Joule **heat**ing; do not accept or prompt on "temperature")