Round 5

Regulation

(Tossup 1) Optical beams named for this mathematician solve Helmholtz's equation under the paraxial approximation. This mathematician names a technique of elimination for linear equations. A law named for this person's scientific work implies that the magnetic flux into any enclosed space should equal the magnetic flux leaving the enclosed space. A famous story involving this mathematician's youth involved him quickly summing all the integers under 100. For the point, name this German scientist who lends his name to the normal distribution.

ANSWER: Carl Friedrich **Gauss**

(Tossup 2) In a form of NMR named for this particle, tetramethylsilane is used as an internal standard for chemical shift. The Grotthuss mechanism was proposed to explain the diffusion of these particles between water molecules. Bronsted defined acids and bases as accepting and donating one of these particles. They can be thought of as a positively charged hydrogen atom that has had its electron stripped off. For the point, name these particles that make up the atomic nucleus with neutrons.

ANSWER: (hydrogen) **proton**s (or **hydrogen ion**s or **hydrogen cation**; accept **hydron**; accept **hydrogen-1**; do not accept or prompt on "hydrogen")

(Tossup 3) The discovery of Ceres and this object were taken as proof of the since discredited Bode's law. This object's satellites include Puck, Oberon, Titania, and many others named for Shakespearean characters. Because its axis is nearly parallel to the ecliptic, this planet rotates on its side, and it was the first planet discovered with the aid of a telescope. Found by William Herschel and named for the Greek god of the sky, for the point, identify this seventh planet from the Sun.

ANSWER: **Uranus**

(Tossup 4) His last name isn't Curie, but this scientist names a non-SI unit of radioactivity equal to one million nuclei decay per second. This scientist is the namesake of the first element *after* the actinide series, element 104. This scientist names a type of elastic scattering between charged particles caused by the Coulomb interaction. This man supervised an experiment run by Geiger and Marsden where alpha particles were fired at gold foil, disproving the plum-pudding model of the atom. For the point, name this scientist who developed the model of the atomic nucleus.

ANSWER: Ernest **Rutherford**

(Tossup 5) This disease is classified as multibacillary [mult-ee ba-SILL-uh-ree] or paucibacillary [paw-see ba-SILL-uh-ree]. It's not tuberculosis, but multidrug therapy to treat this disease uses clofazimine [cloh-faz-ee-meen], rifampicin [ruh-FAMP-uh-sin] and dapsone [dap sohn]. Only armadillos and humans can be infected with this disease caused by a species in the Mycobacterium genus. This disease is sometimes referred to as Hansen's disease. For the point, name this disease that causes nerve damage and skin lesions, a highly contagious disease that led to people being quarantined in namesake colonies.

ANSWER: **leprosy** (accept **leper** colonies; accept **Hansen**'s disease before mentioned)

(Tossup 6) A wier is a type of this structure which may contain a notch allowing for some passage past it. Those built for tailings may be partially built of the tailings themselves. These structures make pumped storage plants possible. Increased rates of sedimentation due to these structures can be mitigated by the use of a sluiceway that bypasses this structure. Jinping 1 is the tallest one of these structures in the world, while Three Gorges is capable of producing the most energy. For the point, name these structures which hold back the flow of water to create a reservoir, possibly for hydroelectric generation.

ANSWER: **dam**s

(Tossup 7) Vinkensport is a competition among members of this class of animals in traditional Flemish culture. The greater honeyguide is a member of this class of animals often used by humans in Africa. Magnetoreception is thought to be responsible for the "homing" behavior of some members of this class, which has been exploited for message delivery. Peregrines are one species in this class used for hunting. For the point, name this class of animals, used by humans in such activities as falconry and cockfighting.

ANSWER: **bird**s (accept **Aves**)

(Tossup 8) The Salar de Uyuni in Bolivia is an example of the deposition of this substance in an endorheic basin. *Atriplex* is a genus of plants known for their ability to tolerate this substance, making them halophytes. Rapid dehydration is a danger of mining this substance, as it easily flakes into the air. The major drivers of oceanic circulation are the temperature and the concentration of this substance. For the point, name this mineral which is present in ocean water in much higher concentrations than in fresh water.

ANSWER: **salt** (accept **sodium chloride** or **halite**)

(Tossup 9) Importin and exportin proteins are responsible for shuttling cargo with NLS and NES signals into and out of this organelle. This organelle is studded with eight-fold symmetric pore complexes that look like mini-basketball hoops. A dense region *within* this organelle is the site of ribosome production. Within this organelle, both eu- [you] and hetero- forms of chromatin exist, depending on gene expression. For the point, name this organelle, where transcription occurs and where DNA is stored.

ANSWER: **nucleus** (accept **nuclear membrane**; do not accept or prompt on nucleolus)

(Tossup 10) All examples of the mineral stishovite found on Earth's surface are associated with these features. Another of these features named for Herschel gives Saturn's moon Mimas an uncanny resemblance to the Death Star. Among the largest of these in the Solar system are Hellas on Mars and Caloris on Mercury, though a notable Earth example is the 560-foot deep Meteor one near Flagstaff, Arizona. For the point, identify these rounded depressions formed by the impact of a solid object on a celestial body.

ANSWER: impact **crater**s (accept **meteorite** until "Herschel"; prompt on "basin")

(Tossup 11) A visitor pattern is used by walkers and changers in these computer programs. The "just-in-time" variety of these computer programs often relies on a virtual machine which can execute bytecode. These programs begin by scanning tokens to create an intermediate representation, which is then optimized before this program turns an input into machine-readable binary code. For the point, name this type of computer program that translates between programming languages, such as Clang, LLVM, or GCC.

ANSWER: **compiler**s

(Tossup 12) A National Laboratory named for these objects in Colorado stores about 17 kilometers worth of these objects. The official stratigraphic boundary between the Pleistocene and Holocene epochs is defined by evidence from one of these objects from Greenland. Dating of isotopes and impurities found within air trapped inside these objects has helped us understand ancient climates. For the point, name these long vertical tubes which are cut as samples from the frozen landscape in places like Antarctica.

ANSWER: **ice core**s (prompt on cores; prompt on ice samples)

(Tossup 13) The Starling equation describes how this material becomes extravascular in the body. FFP is a type of this material collected through apheresis, which separates and returns erythrocytes and leukocytes back to the body. A universal donor for this material is of the AB type, a reversal of what is expected from whole blood donation. For the point, name this yellow-colored fluid made of primarily water, in which other components of blood are suspended.

ANSWER: blood **plasma**

(Tossup 14) VLBI and aperture synthesis are techniques which simulate larger versions of these devices. The Newtonian version of these devices was the first to include a secondary mirror perpendicular to the objective. Chester Moore Hall was the first to use an achromatic lens in one of these devices, helping to correct for the lack of sharpness in previous versions. For the point, name these optical devices built to see distant objects, such as the Hubble and Webb ones in space.

ANSWER: **telescope**s (accept **radio telescope**s until "Newtonian")

(Tossup 15) This data structure is utilized to evaluate expressions when computers are using reverse Polish notation. Forth and PostScript are languages oriented around this data structure which works in the opposite manner to a queue. Implementations of this data structure make use of peek, pop, and push operations. Exceeding the size of this data structure causes its namesake "overflow." For the point, name this last in, first out data structure that places items one on top of the other.

ANSWER: **stack**s

(Tossup 16) Protecting circuits commonly connect two of these devices to ground, anti-parallel to each other. The Esaki variety of this device was one of the first to take advantage of quantum tunneling. Akasaki, Amano, and Nakamura won a 2014 Nobel prize for creating an efficient version of these devices that emits blue light. Circuit diagrams depict these devices as a triangle with a line over one point. For the point, name this circuit element that only allows current to flow in one direction, whose light-emitting variety is abbreviated L.E.D.

ANSWER: **diode**s (prompt on L.E.D.; accept light-emitting **diode**s)

(Tossup 17) A selective type of this chemical reaction can separate the magnesium and calcium in seawater. Qualitative analysis employs a chloride solution to detect silver ions via this reaction. The technique of salting out uses this reaction to purify proteins. Mixing lead nitrate and potassium iodide produces insoluble lead iodide due to this reaction. Hard water stains and stalactites result from, for the point, what type of reaction in which two solutions combine to form a solid compound?

ANSWER: **precipitation** reaction (prompt on "forming a solid"; prompt on "double-replacement" or "double-displacement" reaction)

(Tossup 18) Perimysium groups this tissue into bundles. Two Z-lines and the H-zone are part of the basic unit of this tissue collectively referred to as a sarcomere. This tissue contains a unique organelle responsible for storing calcium ions called the sarcoplasmic reticulum. One type of this tissue is divided into "slow twitch" and "fast twitch" varieties. The sliding filament model explains the movement of this tissue through interactions between actin and myosin. For the point, name this tissue that is responsible for contraction in the heart and skeletal movement.

ANSWER: **muscle** tissue (accept **smooth muscle**; accept **skeletal muscle**)

(Tossup 19) Two of these regions named P1 and P2 form only in waterlogged conditions. The stonelayer may appear at the base of one of a silica-rich one of these regions named E, marking the lowest depth of the biomantle. Those little affected by pedogenesis are denoted by the letter C, while the one of these denoted B often contains oxides. The topmost one of these regions may contain significant humus. For the point, name these regions or layers in a soil profile which show different characteristics.

ANSWER: soil **horizon**s

(Tossup 20) Degenerate matter hypothesized to exist in the center of these objects come in whimsically-named "pasta phases" like "lasagna" and "spaghetti." The crust of these objects can shift to cause starquakes which result in "glitches" that increase the rotation of these objects. The mass of these objects is bounded by the Tolman-Oppenheimer-Volkoff limit. When these objects spin rapidly they can be classified as a magnetar or pulsar. The smallest and densest observed star type to date is, for the point, what stellar remnant primarily composed of just one type of particle?

ANSWER: **neutron** stars (prompt on "pulsar" or "magnetar" before read)

(Tossup 21) This type of number is multiplied times the coefficient and then decreased by one in a rule for taking the derivative. The degree of a polynomial is defined by the largest one of these numbers. Roots can be written using fractional types of these numbers, and simplified fractions never have negative numbers of this type. The operation named for these numbers can be thought of as repeated multiplication. For the point, name these numbers written using superscript that define the number of times the base is multiplied by itself.

ANSWER: **exponent**s (accept **power**s)

(Tossup 22) One early published recipe for this substance included both honey and the toxic realgar. This substance was discovered by alchemists looking for an elixir for immortality per the Taoist tradition. A man named Iron Li is legendarily said to have used this substance inside a ceramic bottle to scare foxes, while its original use may have been in so-called "fire arrows." For the point, name this substance, a mixture of charcoal, sulfur, and saltpeter discovered to be explosive by Chinese inventors around 850 AD.

ANSWER: **gunpowder** (accept **black powder**)

(Tossup 23) Lodgepole pines are one example of a species that requires this phenomenon to reproduce. Plats known as resprouters dominate after this phenomenon, such as occurs in the California chaparral landscape. In late 2018, President Trump incorrectly reported that Finland reduces this phenomenon through raking. This phenomenon causes soil to become more basic, thought to be due to the ash it creates. For the point, name this phenomenon that is used to create new farmland in the "slash and burn" procedure.

ANSWER: forest **fire** (accept **wildfire**; prompt on burning)

(Tossup 24) The radial variant of this system is one of two possible potentials with bound and closed orbits, according to Bertrand's theorem. The quantum analogue of this system has energy levels h-bar times omega apart. Each atom behaves as one of these systems in the Einstein model of a solid. The Q-factor determines how much damping occurs in these systems. A classic example of one of these systems is a mass attached to the end of a spring that can be described by Hooke's law. For the point, name these systems that experience sinusoidal, periodic motion.

ANSWER: **harmonic oscillator** (accept simple **harmonic oscillator**; accept quantum **harmonic oscillator**; accept radial **harmonic oscillator** accept **SHO**; accept **QHO**; acceot **RHO**; prompt on oscillator; prompt on spring)

(Tossup 25) An ancient one of these objects is commonly called the "T and O" after the shapes that make it up. An icosahedron is used in Buckminster Fuller's "Dymaxion" one of these objects. Isopleths can be displayed on these objects, such as contour lines showing relief. Software generating these objects is known as GIS, and creating these objects requires a choice of projection such as Gall-Peters or Mercator. For the point, name these navigation aids constructed by people called cartographers.

ANSWER: **map**s

(Tossup 26) A molecule with this many carbon atoms has 1,3 diaxial strain from its flagpole hydrogens that makes it less stable in its boat conformation than in its chair conformation. This many atoms surround the central atom in pentagonal pyramidal and octahedral geometry. This many *total* electrons are shared in the bonds of an alkyne [rhymes with fine]. Glucose contains this many carbons. This is the number of valence electrons in a single atom of oxygen. For the point, how many carbons are in cyclohexane?

ANSWER: **six**

(Tossup 27) The Nankai trough contains a large field of these compounds which Japan may exploit for energy production. A hypothesis called this compound's "gun" suggests a positive feedback loop for global warming due to the melting of these compounds. Typically found on the continental shelf, these compounds form when a product of anaerobic bacterial decay mixes with water at low temperatures and high pressures. For the point, name these compounds which consist of CH_4 trapped within cages of ice.

ANSWER: methane **clathrate**s

(Tossup 28) Phragmosomes form prior to this process in plants. When nuclear lamina are phosphorylated, one stage of this process allows microtubules to begin attaching themselves to kinetochores. After the spindle checkpoint, sister chromatids are cleaved during anaphase and begin to separate into two new nuclei during this process's telophase. Occurring after G2 interphase is, for the point, what process of cell division that results in two daughter cells identical to the original cell?

ANSWER: **mitosis**

(Tossup 29) A unique form of these materials has smectic and nematic phases. Materials in this form are labelled with Miller indices before firing a beam of electrons at them to study their structure from the diffraction pattern. Louis Pasteur discovered chirality while studying tartaric acid in this form. In solid state physics, the unit cell and a geometrically repeated pattern defines the lattice of these structures. For the point, name these regularly structured solids, whose "liquid" variant is used in LCD TVs.

ANSWER: **crystal**s (accept **crystalline** solids)

(Tossup 30) Two atoms of this type share a bond in ylides [ill-ides]. SN1 reactions precede via the production of this type of carbon atom. Adding a "common" compound that shares this characteristic with a product already in solution will decrease solubility of a solute and usually shifts pH. In addition to being the conjugate base to acetic acid, acetate is this type of molecule. This type of atom usually has a plus sign or a negative sign written next to it. For the point, name this type of atom with net electric charge.

ANSWER: **ion**s (accept **ionic** or **cation** [cat-"eye"-on] or **anion** [an-"eye"-on]; accept any indication of non-zero charge until "electric" is read)

Backup

(Tossup 31) The removal of hydrogen from this substance is responsible for the release of oxygen during photosynthesis. The non-polarity of lipids makes them useful for protecting against this substance, such as by creating micelles or waxes. Respiration and uresis both release this substance from the body. The crystal structure of this substance's solid form allows it to float, thus protecting marine life from freezing temperatures. For the point, name this substance necessary for life in which marine life swims.

ANSWER: **water**

(Tossup 32) The irregular Canis Major is the nearest galaxy that can be described by this adjective. Many Kuiper Belt objects like Haumea and Makemake can be described by this term, thanks to a new category created in 2006. Along with "red", this term describes the majority of stars in the Milky Way, and in about seven billion years the Sun will become a white star of this type. For the point, give this term for a relatively diminutive astronomical object, the opposite of a giant.

ANSWER: **dwarf** (accept **dwarf galaxy**, **dwarf planet**, **dwarf star**, **red dwarf**, and **white dwarf**)