

# Finals

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## Regulation Tossups

(1) **The Maggi-Righi-Leduc effect focuses on changes in this quantity that are caused by a magnetic field. A fraction in which this quantity is the denominator is multiplied by the characteristic length to give the Biot number. Laser flash analysis (+) is used to calculate a form of diffusivity in which this quantity is divided by the product of density and heat capacity. (\*)** Dividing the heat flux by the temperature gradient times negative 1 gives this quantity, according to Fourier's law. For the point, identify this quantity that is low in insulated materials, a heat-related measure symbolized k.

ANSWER: **Thermal Conductivity** (prompt on "Conductivity;" prompt on "K" before mentioned)

(2) **Although this is the only ratio that can measure a liquid's response to stress, only Hooke's law, instead of this ratio, can be used to describe the behavior for anisotropic solids such as wood or paper. This quantity's inverse is the isothermal compressibility of a material at fixed temperature. (+)** This quantity is calculated by an object's volumetric stress divided by its volumetric strain. (\*) Symbolized as either B or K, this is, for the point, what modulus that measures an object's resistance when compressed on all sides?

ANSWER: **Bulk** Modulus

(3) **One of the namesakes of this experiment attempted to lower the vacuum of the apparatus involved after learning about failed attempts by Walter Elsasser and James Chadwick to generate one of the results of this experiment. George Thompson (+) independently produced the same result as this experiment, which confirmed Bragg's Law and involved the use of a crystal of nickel. (\*)** This experiment resulted in a diffraction pattern arising from the scattering of its central particles. For the point, name this experiment that confirmed de Broglie's predictions about wave-particle duality.

ANSWER: **Davisson-Germer** Experiment

(4) **The recalculation of a quantity related to this process led to the discovery of a previously missing factor known as the "Thomas half." The frequency with which one variety of this process occurs can be calculated by the negative product of the magnitude of an applied magnetic field and the gyromagnetic ratio. (+)** The lack of an external moment acting on the subject of this phenomenon is characteristic of one variety of this process which comes in Larmor (\*) and torque-free forms. For the point, name this shift in a body's rotational axis, often described as planetary wobbling.

ANSWER: **Precession** (accept Torque-free **Precession**)

(5) **One example of these particles named for Wu and Yang provided the first solution to the Yang-Mills field equations. Two of these particles are connected by a theoretical Dirac string and are equivalent to dyons with zero electric charge. Maxwell's equations would need to be written symmetrically to accommodate (+) the existence of these particles, which would cause the divergence of the B-field to be non-zero and thus violate (\*) Gauss's law for magnetism. For the point, name these hypothetical particles that consist solely of a north or a south magnetic end.**

ANSWER: Magnetic **Monopoles** (accept Wu-Yang **Monopoles**)

(6) **In materials exhibiting this property, a quantity symbolized capital D is calculated by multiplying a different quantity by the 3x3 permittivity tensor, rather than a scalar. Optical rotation is sometimes known as the circular variety of (+) this property, which is produced by one phenomenon in the Pockels effect. Waveplates are made out of material that exhibits this property that was first observed in (\*) calcite. Commonly occurring in crystals, this is, for the point, what quality in which the polarization of a material determines its refractive index?**

ANSWER: **Birefringence**

(7) **The carbon atom in a Grignard reagent serves as this type of species during its attack on a carbonyl group. Curved arrows are drawn pointing away from one of these species in the "arrow-pushing" method. One of these species inverts a chiral center (+) when it performs backside attack during an SN2 reaction, which is a substitution reaction named for these species. These compounds can be classified as (\*) Lewis bases because they often have a free lone pair. For the point, name these electron-rich species, which are contrasted with electrophiles.**

ANSWER: **Nucleophiles** (accept **Lewis Bases**; accept **Nucleophilic** Substitution; prompt on "Bases")

(8) **Friedrich Stromeyer and K.S.L Hermann are both credited with discovering this element, which Hermann found while studying zinc oxide. A form of mass poisoning caused by this element in Japan was known as Itai-itai disease. (+) Photovoltaics that provide a cheaper alternative to solar cells make use of this element's crystalline compound form telluride. Partly due to its toxicity, lithium-ion batteries (\*) are increasingly replacing batteries made up of nickel and this silvery-white element with atomic number 48. For the point, name this chemical element with symbol Cd.**

ANSWER: **Cadmium** (accept **Cd**)

(9) **Catalysts with this property such as BINOL can be produced using asymmetric synthesis. Molecules with this property are analyzed using circular dichroism spectroscopy. Molecules with this property can be labeled L or D (+) depending on the way they rotate plane-polarized light. Isomers with this property that form the two parts of a (\*) racemic mixture are enantiomers. For the point, name this property of molecules that cannot be superimposed on their mirror images, a property named for the Greek for "handedness."**

ANSWER: **Chirality** (accept **Enantiomers** before mentioned; accept **Optically Active**)

(10) **One element in this family was initially called brevium due to its short half-life. The radioactive decay of another element in this family is single-handedly the largest contributor to the internal heat of Earth, and that element is named after a (+) Norse god. Consisting of 15 elements, this subdivision of the periodic table includes thorium, (\*) nobelium and californium amongst its members and is found below a family containing elements like gadolinium. Largely on the f-block, this is, for the point, what group of metallic elements that share similarities with lanthanides?**

ANSWER: **Actinides** (accept **Actinoids**; accept **An**)

(11) **A multilayer form of this process is described by BET theory, which extends the idea of fractional coverage in an isothermal model of this process proposed by Langmuir. Poisoning deactivates catalysts by impeding (+) this process, and porous materials like zeolites and activated charcoal can use this process to remove compounds from the air because of their (\*) high surface area. Molecules adhere to a solid surface but do not pass through in, for the point, what process often contrasted with absorption?**

ANSWER: **Adsorption** (do not accept or prompt on "Absorption")

(12) **Justinus Kerner discovered this group of microorganisms, but his findings were not scientifically published until Emile van Emengem classified this group as a type of Bacillus. The Schaeffer-Fulton stain is used by microbiologists to differentiate endospores produced by these groups of (+) Gram-variable bacteria, and that quality earns these groups the classification of obligate anaerobes, which produce (\*) bottle-shaped endospores. For the point, name this genus that includes the bacteria that cause botulism and tetanus.**

ANSWER: **Clostridium**

(13) **Ernst Werner von Siemens financed a museum's sale of a fossil of this genus, which had originally been sold by a farmer in exchange for a cow. The aforementioned Berlin Specimen was a fossil of this genus, which was preceded by the *Aurornis* genus. The "type species" of this genus is referred to as (+) *lithographica*, and hyperextensible toes and frond-tail plumage were characteristics of this Late Jurassic genus of the (\*) Avialae clade, which was confirmed to have feathers. For the point, name this genus of dinosaurs that are considered the forerunner to modern birds.**

ANSWER: **Archaeopteryx** (accept **Urvogel**)

(14) **Models of this process proposed by Gleason and Clements differ in their emphasis on a climax group. The role of abiotic factors in this process distinguishes its allogenic form from its autogenic form. During this process, intermediate seral communities (+) are established in stages after the initial colonization by a pioneer species. The secondary type of this process is triggered by (\*) disturbances such as floods or forest fires. For the point, name this gradual change in the species structure of a given area over time characterized by replacement within a community.**

ANSWER: Ecological **Succession** (accept Primary **Succession**; accept Secondary **Succession**)

(15) **Male populations of these carnivorous organisms create elaborate nests glued together by the protein spiggin. Changes in the regulatory switch regions of the PITX1 [[pit-ex-one]] gene can lead to morphological differences in this organism such as a loss of the pelvic spine. (+) A landmark study in the ethology of this fish was documented by Niko Tinbergen in *The Study of Instinct*, (\*) in which this organism was observed engaging in mating rituals and demonstrating fixed action patterns. For the point, name this three-spined family of fish commonly studied in evolutionary biology.**

ANSWER: **Stickleback** Fish

(16) **Rapamycin targets one of these enzymes called mTOR that normally inhibits autophagy. The MAP signal transduction cascade functions through a series of the "serine-threonine" type of these enzymes. In the first step of (+) glycolysis, one of these enzymes transfers a functional group to a hexose sugar to form G6P, and phosphatases reverse (\*) the activity of these enzymes. ATP often serves as a cofactor of, for the point, what enzymes that transfer a phosphate group to another molecule?**

ANSWER: **Kinases** (accept Serine-threonine **Kinases**; accept MAP **Kinases**; accept Hexo**kinases**)

(17) **Pandy's test can detect elevated protein levels in this substance to help diagnose Guillain-Barré syndrome, and oligoclonal bands are detected in this substance in patients with multiple sclerosis. Ependymal cells within the choroid plexus secrete the majority of this substance before it flows into the (+) subarachnoid space between the meninges. Intracranial pressure is mediated by this liquid, which is extracted during a (\*) lumbar puncture, which is also known as a spinal tap. For the point, name this clear fluid that surrounds the brain and spinal cord in the central nervous system.**

ANSWER: **Cerebrospinal Fluid** (or **CSF**)

(18) **Gytta is a type of mud formed from this material, which can be found in abundance in the Carbajal Valley of Argentina. This material is commonly found in peloids used in balneotherapy, and this material that is often used in histosols comprises a series of features on Sumatra's northeast coast known as (+) swamp forests. This material has a one millimeter annual growth rate that makes it effectively nonrenewable, and this material often includes *Sphagnum* moss for which is alternatively named. For the point, identify this collection of decayed vegetation found in namesake bogs.**

ANSWER: **Peat** (accept **Peat** Moss; accept **Peat**land; accept **Peat** Bogs)

(19) **One of these places referred to by the word "Untersee" is found in the Gruber Mountains. In 2020, scientists found an rRNA sequence in one of these places that was greater than 97% similar to that of the *Notothenia coriiceps* species of (+) rock cod. Radio Echo Sounding is often used to study the 379 examples of these places, including ones named for John Mercer and Lincoln Ellsworth. Freon was used to keep a borehole open (\*) when studying one of these places, a meltwater variety of which was found near Shackleton Ice Shelf. For the point, name these often subglacial bodies of water on the world's southernmost continent.**

ANSWER: **Lake**s of **Antarctica** (accept word forms such as **Antarctic Lake**s; prompt on "Subglacial Lake;" prompt on partial answers)

(20) **The Carnian Pluvial Episode occurred during this period which saw the first known appearance of stony corals. Conodonts were entirely wiped out during the one of the "Big Five" extinction events during this period (+) in which archosaurs were dominant. Pangaea began to split during this period that saw the evolution of the earliest true mammals (\*) and was preceded by an event known as the Great Dying. The mass extinction at the end of the Permian was followed by, for the point, what geological period that preceded the Jurassic?**

ANSWER: **Triassic** Period

(21) **The first of two B-modes was conjectured to have originated during this process, which is explained by a scalar field descending an energy hill in the slow-roll model. The theory regarding this process was furthered by the proposal of a form of vacuum decay (+) that would solve the monopole problem, which was a subtype of the horizon problem. Alan Guth was among the pioneers of this theory, which is said to have begun (\*)** 10 to the negative 36 seconds after the Big Bang. For the point, name this proposed process for the rapid expansion of the early universe.

ANSWER: Cosmic **Inflation** (accept Cosmological **Inflation**)

(22) **The Sun, and R Doradus, are the only stars other than this one that appear to have a higher diameter when viewed from Earth. The name of this star derives from an Arabic term partly referring to a word for "hand," (+) and, in 2019 and 2020, this star experienced a decrease in brightness known as the "Great Dimming." (\*)** Along with Procyon and Sirius, this star is one of the vertices of the Winter Triangle, and in the larger Winter Hexagon this star is northwest of Bellatrix. For the point, name this alpha star in Orion that, despite its designation, often appears dimmer than Rigel.

ANSWER: **Betelgeuse** (accept **Alpha Orionis**)

(23) **Signals from these devices provide the basis for the shock pulse method of condition monitoring. A metric often specified in these components is known as the "L10" life, and that metric gives the length of time before 10% of these components will fail (+) within a particular group. The journal of these components lacks one type of element in the plain variety, and rolling-elements of (\*)** these components characterize their "ball" variety. For the point, identify these circular mechanical components that restrict motion.

ANSWER: **Bearings** (accept Ball **Bearings**)

(24) **Classification algorithms in machine learning employ this technique's logistic form, which requires a categorical dependent variable. In this technique, the source of variation in a data set is quantified by the coefficient of determination (+), which is symbolized "R-squared." The sum of the squared residuals is minimized in the "ordinary least squares" approach (\*)** to this technique's linear form. For the point, name this statistical technique that models the relationship between two variables by fitting a line to a set of data.

ANSWER: **Regression** (accept Linear **Regression**; accept Logistic **Regression**)

(25) **The full output of one of these systems is referred to as its firm capacity. Islanding can result from the absence of these systems, which can experience rotational load shedding. In these systems, substations are able to receive the central product over long distances through (+) transmission, whereas distribution protocols provide said product to individuals. (\*)** Brownouts can result from drops in voltage along these systems, which can experience rolling blackouts. Supplied by power stations, these are, for the point, what interconnected systems that transmit electricity?

ANSWER: **Power Grid** (accept **Grid**; accept Electrical **Grid**; prompt on "Power Supply;" prompt on "Power Station" before mentioned; prompt on "Generator")

(26) **Attaching this shape to the edge of a disk produces a surface called a cross-cap. The real projective plane can be topologically constructed from this shape, which yields paradromic rings when repeatedly cut along the center line. (+)** This shape is produced by splitting a Klein bottle along its plane of symmetry, and this shape with an Euler characteristic of zero is the (\*) simplest non-orientable surface. For the point, identify this shape that is named for a German mathematician and formed by making a half-twist in a strip of paper and linking the ends together.

ANSWER: **Möbius Strip** (or **Möbius Band**)

(27) **The term "exemplar" was introduced in the postscript of this work, which was criticized at an International Colloquium attended by such scholars as Imre Lakatos. It's not by Wittgenstein, but this book that uses an example of a duck-rabbit (+) was used to illustrate the change in one's perception of a given entity with new information. According to this work, periods of "puzzle-solving" (\*) occur within existing frameworks characterized by the "normal" form of one study. Citing Copernicus' breakthroughs as an example of a "paradigm shift," this is, for the point, what landmark work in the history of science by Thomas Kuhn?**

ANSWER: *The **Structure of Scientific Revolutions***

(28) **After helping develop the M26 Pershing and the M4 Sherman, Gladeon Barnes helped oversee the creation of this entity whose operators were chosen by Herman Goldstine. ABC and Z3 were among the competitors to this entity developed by (+) John W. Mauchly and a student at the Moore School of Engineering in Pennsylvania. Originally built for artillery table calculations, this device was made out of (\*) vacuum tubes and was referred to as the "Giant Brain" by media outlets. For the point, identify this Turing-complete device, a general-purpose digital computer that served as a forerunner to UNIVAC.**

ANSWER: **ENIAC** (accept **Electronic Numerical Integrator and Computer**)

(29) **In the topological variety of these systems, the world lines of anyons create braids, which serve as one of their key components. Daniel Loss and David P. DiVincenzo developed the concept of one of these systems that relied on the control of (+) electron spin in one of their components. The states of these systems are difficult to sustain due to state fidelity and decoherence, and the logic gates (\*) of these devices run on qubits. For the point, name these devices that perform calculations using principles from a non-classical theory of physics.**

ANSWER: **Quantum Computer** (accept word forms such as **Quantum Computing**; prompt on partial answers; accept Topological **Quantum Computer**)

(30) **This man's claim that intent is never manifest is used to undermine what he calls the "conspiracy theory of society." One notion developed by this man claims that propositions can differ in their degree of truth, a concept he called verisimilitude. (+) This man criticized Hegel and Marx for contributing to the existence of modern totalitarianism in a work that argues against history's determination by universal laws. This man championed (\*) falsifiability instead of inductive reasoning in his examination of the scientific method. For the point, name this analytic British-Austrian philosopher who wrote *The Logic of Scientific Discovery*.**

ANSWER: Karl **Popper**

(31) **This element has a 211 isotope that is preferred to iodine-131 in nuclear medicine applications involving low tumor burdens. This element with a low, eight-hours half-life has a name that is derived from a Greek term meaning (+) "unstable." This element is the least reactive among the halogen group, and the 210 isotope is the most stable one of this element, which is the rarest element to occur naturally (\*) in the Earth's crust. For the point, name this element with atomic number 85 and chemical symbol At.**

ANSWER: **Astatine** (accept **At** before mentioned)

(32) **A 2018 Nature article claimed that Munster researchers had used techniques similar to those of this program in chemical synthesis. The similar Darkforest was made public after an event involving this program, which uses both "policy networks" and "value networks." The (+) Zero version of this program was notably entirely self-taught and made use of reinforcement learning, and this 19x19 object was the subject of a 2015 event involving in which the (\*) 9-dan Lee Sedol was defeated. For the point, name this DeepMind program specializing in a Chinese board game involving black and white stones.**

ANSWER: **AlphaGo** (accept **AlphaGo Zero**)



(33) **In the normal type of these structures, a-site cations fill one-eighth of the tetrahedral sites while the B-site cations fill one-half of the octahedral sites. A unit cell of these structures is made up of eight face-center cubic cells. Divalent cations, trivalent cations, (+) and elements such as oxygen, sulfur, selenium, or fluorine make up the stoichiometry of these structures, and these structures follow the chemical arrangement of (\*) AB<sub>2</sub>O<sub>4</sub>.** For the point, name these close-packed structures that are often cubic crystal systems and shares their name with a gemstone with formula MgAl<sub>2</sub>O<sub>4</sub>.

ANSWER: **Spinel**

(34) **A concentration of a basic subtype of these regions is referred to as the Lost City. William Martin and Michael Russell claimed that the origin of life may have occurred in these places, an idea that was the subject of Günter Wächtershäuser's "iron-sulfur world theory." (+) Silicon and calcium are emitted by the lighter colored "white smoker" variety of these entities that contrast with the "black smoker" (\*) type, which is chimney-like in appearance and usually found in the bathyal zone. Often found at hotspots and volcanically active areas, these are, for the point, what fissures in the ocean floor?**

ANSWER: **Hydrothermal Vents** (accept **Hydrothermal Chimney** before "Chimney" is read and prompt after; accept **Black Smokers** until read; accept **White Smoker** until read; prompt on "Ocean Floor" or "Seafloor" before "Floor" is read)

(35) **The distortion of this phenomenon, through inverse Compton scattering by electrons, underlies the Sunyaev-Zeldovich effect. The WMAP [{"W"-map}] and COBE [{"CO-bee}] spacecrafts measured anisotropies of this phenomenon, which consists of (+) photons that have propagated since the epoch of recombination. This phenomenon exhibits the most perfect black-body spectrum observed in nature (\*), with a temperature of about 2.7 Kelvin. For the point, name this radiation left over from the Big Bang that has a frequency between radio and infrared.**

ANSWER: **Cosmic Microwave Background** Radiation (or **CMB** or **CMBR**; accept **Relic Radiation**; prompt on partial answers)

### Extra Questions

(1) **This chemical compound was once used as an over-the-counter laxative, but it was discontinued due to the frequency of erythrocytes that can cause cancer. Despite its carcinogenicity, this compound is often mixed with sodium hydroxide to produce 'disappearing' ink (+) in toys. This compound was initially synthesized under acidic conditions by Adolf von Baeyer, and a reduced form of this compound is used to (\*) detect blood in substances using the Kastle-Meyer test. For the point, name this compound often used as an indicator in acid-base titrations.**

ANSWER: **Phenolphthalein**

(2) **The Englert-Greenberger-Yasin relation quantifies the results of this experiment, a non-overlapping version of which was carried out by G. I. Taylor. Claus Jönsson pioneeringly used a lone electron when performing this experiment, an earlier variety of which demonstrated the (+) disappearance of fringes when an obstructing object was placed in front of a beam. That experiment formed patterns (\*) that demonstrated interference. For the point, name this experiment by Thomas Young that supported the wave theory of light, named for the twin apertures used.**

ANSWER: Young's **Double slit** Experiment (accept Young's **Interference** Experiment before "Interference" is read; accept Young's **Double-slit** Interferometer; accept Claus Jönsson's **Double-slit** Experiment; accept (Sir) G(eoffrey) I(ngram) Taylor's **Double-slit** Experiment)