

Finals

Regulation

(Tossup 1) The Fields Medal in Mathematics depicts an image of this man and a description of his sphere and cylinder proof. This man used a primitive precursor of integral calculus to estimate pi, and in this man's *On the Equilibrium of Planes*, he gave the earliest explanation of levers. The second volume of his *On Floating Bodies* proposed his eponymous principle. For the point, identify this man, who according to Vitruvius used that namesake principle to determine the metal composition of a crown by using water displacement.

ANSWER: Archimedes

(Tossup 2) Examples of these activities include Hackenbush and Nim. A cellular automaton invented by John Conway is known as one of these activities "of Life." One of these activities that has benefits balanced by costs is called "zero-sum." A Nash equilibrium occurs if none of the participants in these activities can gain by changing their strategy. For the point, name these activities like go and chess.

ANSWER: mathematical games

(Tossup 3) The Morrison formation is an abundant source of fossils from this geological period. During this period, the supercontinent Pangea rifted to form Laurasia and Gondwana. The oldest known bird, the Archaeopteryx [ar-KEE-op-ter-icks], lived in this geological period that also included the Stegosaurus. For the point, name this middle period of the Mesozoic Era that took place after the Triassic and before the Cretaceous period.

ANSWER: Jurassic period (accept Late Jurassic period)

(Tossup 4) It's not the stomach, but some people have an extra part of this organ called the Duct of Santorini. This organ's Duct of Wirsung empties its contents into the duodenum. Amylin and glucagon are produced by alpha and beta cells in this organ's Islets of Langerhans. Type 1 diabetes targets, for the point, what organ that secretes insulin?

ANSWER: Pancreas

(Tossup 5) This is the color of light produced by a protein isolated from the jellyfish *Aequorea victoria*. That protein is used in cellular microscopy and is known as "this color" fluorescent protein. This most common form of color blindness prevents afflicted individuals from seeing red and this color. This is the color of unripened tomatoes which are a popular fried dish, and this color describes a classification of trees that have leaves year round. For the point, name this color of most grass.

ANSWER: green (accept evergreen; accept green fluorescent protein)

(Tossup 6) This metal stabilizes two histidine and two cysteine residues. Gag knuckle is an example of a DNA-binding domain named for this element's "finger." A coat of this element is added to steel or iron to slow the process of rusting. Due to the value of this metal, the production cost of a penny, which is mostly this element, is greater than 1 cent. Brass is formed by combining copper with, for the point, what metal with atomic symbol Zn?

ANSWER: Zinc (accept Zn before it is read)

(Tossup 7) These organisms were labeled with Sulfur-35 and Phosphorus-32 to show that DNA contains the information for inheritance in the Hershey-Chase experiment. These organisms, which can undergo the lytic or lysogenic cycle, include the lambda and T-4 types, which often infect E. coli. For the point, name these viruses that infect bacteria.

ANSWER: Bacteriphage (prompt on viruses)

(Tossup 8) A primitive type of these devices can use gun-type assembly to fire on piece of metal into another. This technology was succeeded by a much more power version utilizing the Teller-Ulam design which included a secondary stage fueled by heavy hydrogen isotopes. Centrifuges are required to separate particular isotopes which are used for nuclear fission, typically of uranium or plutonium. For the point, identify these weapons, only two of which have ever been used in combat near the end of World War II.

ANSWER: nuclear weapon (accept: atomic bomb; accept; nuclear bomb; accept atomic weapon)

(Tossup 9) This region is composed mostly of materials that contain magnesium and silicon. A remnant from Keith Bullen's naming system – the D-double-prime layer – is found in the lower portion of this region. Containing the asthenosphere, this region is bounded by the Gutenberg and Moho discontinuities and makes up most of the Earth's volume. For the point, name this solid region divided into "upper" and "lower" portions which is between the Earth's core and crust.

ANSWER: Earth's mantle (accept upper mantle; accept lower mantle)

(Tossup 10) WIMPs and MACHOs are two proposed bodies to explain the presence of this entity. This entity was first suggested by Dutch astronomers Jacobus Kapteyn and Jan Oort. Galaxies that are thought to contain this substance have faster rotation than what is calculated by just their visible mass. For the point, name this mysterious form of matter, named because it does not emit any detectable light.

ANSWER: dark matter

(Tossup 11) In the Wallace effect, this process prevents the production of sterile hybrids to assist in speciation. Examples of this process include changes in coloration of peppered moths and beak size variation of Galapagos finches. For the point, name this process that preserves favorable variations in organisms, proposed by Charles Darwin.

ANSWER: natural selection (prompt on evolution; do not accept sexual selection)

(Tossup 12) A gas's value for this quantity is multiplied by total pressure to find the partial pressure of a gas according to Dalton's law. Colligative properties depend on this quantity, which can be found via a titration. For the point, name this quantity, often measured using molarity, which refers to how much solute is in an amount of solvent.

ANSWER: **concentration**

(Tossup 13) One form of this process results in the formation of three polar bodies due to unequal cytoplasmic division. An error in this process leads to Turner syndrome and Down syndrome. Almost 90% of this process's total time occurs in Prophase I. For the point, name this method of cell division resulting in four non-identical gametes.

ANSWER: **Meiosis**

(Tossup 14) One type of this rock is classified based on the size of its gravel clasts and is called conglomerate. These rocks are often deposited in layers called strata. Examples of this rock type include limestone and sandstone. For the point, name this type of rock formed from accumulation of settled particles, contrasted with metamorphic and igneous.

ANSWER: **Sedimentary** rock

(Tossup 15) Three of these interactions are present between guanine and cytosine in DNA. Hydrogen sulfide has a much lower boiling point than water because of these interactions. They are the reason that ice is less dense than water. For the point, name these weak noncovalent bonds in which the lightest element is shared between two atoms.

ANSWER: **hydrogen bond** (accept **H-bond**; prompt on bond)

(Tossup 16) Simpson's rule uses this shape to approximate integrals. This shape can be formed by intersecting a plane with a cone parallel to its slant height. This curve is the locus of all points equidistant from the focus and the directrix. For the point, name this conic section with eccentricity of one, the graph of a quadratic function.

ANSWER: **Parabola**

(Tossup 17) The first appearance of this class of arthropods defines the start of the third stage of the Cambrian era, and this class would survive mass extinctions until finally going extinct at the Permian-Triassic extinction. A horseshoe shaped "head shield" or cephalon was one of the defining three lobes of this class. For the point, identify this class of marine arthropods, which with over 17,000 identified species, is considered the most diverse class of animals that has gone entirely extinct, a class named for their three lobes their body was divided into.

ANSWER: **Trilobites** (accept **Trilobita**)

(Tossup 18) In 1992 the first exoplanets were discovered orbiting one of these objects. The *Pioneer* and *Voyager* spacecraft each have a map showing the location of our sun relative to several of these objects. Jocelyn Bell Burnell and Antony Hewish discovered the first of these objects, and at first could not discount that they had detected an artificial radio broadcast. For the point, identify these objects, a type of neutron star which is believed to emit a beam of radiation along its magnetic poles which can be detected as these objects rotate.

ANSWER: Pulsars (prompt on neutron star(s) until the word map is read)

(Tossup 19) A phenylalanine residue is deleted in the Delta-F508 mutation causing this disorder. In infants, this condition is diagnosed via a bowel obstruction called meconium ileus. Pilocarpine is drawn under the skin to screen for this disorder in a sweat test. This autosomal recessive genetic condition occurs when a mutated CFTR protein cannot transport chloride ions, leading to thick mucus buildup in the lungs. For ten points, name this disorder abbreviated CF.

ANSWER: cystic fibrosis (accept CF before it is read)

(Tossup 20) Plotting this quantity against time yields a curve which plateaus at a maximum value symbolized K. Bottlenecks result from a decrease in this quantity, which can be found by marking individuals and then recapturing a random sample. For the point, name this quantity, the number of organisms of a given species in an area.

ANSWER: population size (accept either underlined word; accept number of individuals)

(Tossup 21) Organisms in the root nodules of legumes break down the strong triple bond holding this molecule together. This compound is broken down using an iron catalyst in the Haber process, which produces two molecules of ammonia. For the point, name this gas “fixed” by some plants, the most abundant in the atmosphere.

ANSWER: Dinitrogen gas (accept N₂)

(Tossup 22) Fatty acids are reacted with these compounds in saponification reactions to form soaps. These compounds donate electron pairs according to the Lewis definition and dissociate in water to form hydroxide ions in the Arrhenius definition. For the point, name these compounds with a pH greater than 7, contrasted with acids.

ANSWER: bases

(Tossup 23) Patients with HNPCC have a higher risk of developing cancer in this organ. It is examined during a sigmoidoscopy, which is like another procedure that inspects this organ using a fiber optic camera on a flexible tube to detect polyps or ulcerative colitis. The first part of this organ contains the cecum and the appendix. For the point, name this part of the gastrointestinal tract that absorbs water from waste received from the small intestine.

ANSWER: large intestines (accept colon; prompt on rectum)

(Tossup 24) This quantity can be calculated by multiplying rho times length over cross-sectional area. Power is equal to the product of this quantity and current squared. This quantity is the reciprocal of conductance. Voltage divided by current gives, for the point, what electrical quantity measured in ohms?

ANSWER: resistance

(Tossup 25) The Lancet published a controversial paper about these preparations authored by Andrew Wakefield that purported to have found a link between them and autism. Boosters are used to revamp antigen levels first established by these substances. For the point, name these biological preparations of viral particles, designed to teach the body to adapt to a pathogen such as smallpox or measles.

ANSWER: vaccines

(Tossup 26) The largest family of these animals is the Nymphalidae, also known as the brush-footed example. Birdwings are examples of the swallowtail variety of these animals. One of these animals of the genus *Danaus* is also named for its consumption of milkweed. Mimicry is commonly displayed in these animals, such as the viceroy. For the point, name these colorful flying insects that include the migrating orange “monarch” variety.

ANSWER: butterfly (accept butterflies)

(Tossup 27) About two and a half of these particles are released upon the fission of U-238. An experiment discrediting the gamma ray hypothesis proved the existence of these particles and was carried out by James Chadwick. Isotopes of an element differ in the number of, for the point, what subatomic particle with no electric charge?

ANSWER: neutron

(Tossup 28) In the technique developed by Yamanaka, these cells can be induced using a cocktail of Sox2, Oct-4, and Nanog. Plants produce these cells in the apical meristem. In humans these cells are found in the umbilical cord and bone marrow, and they can be totipotent or pluripotent. For the point, name these cells that can differentiate into specialized cells that come in adult and embryonic types.

ANSWER: stem cells

(Tossup 29) Of this island’s three original volcanic cones, only Rakata partially survives. A fourth cone that emerged from the remains of this island partially collapsed in December 2018 and triggered a tsunami in the Sunda Strait. One eruption from this volcanic island killed over 35,000 people, and altered global climate for the next two years. For the point, identify this Indonesian island which lost two-thirds of its landmass in the explosive eruption of August 1883.

ANSWER: Krakatau (accept Krakatoa)

(Tossup 30) One man with this last name discovered nitrogen in 1772. Another man with this last name created a namesake experiment that was also called the Geiger-Marsden experiment. That man with this last name fired alpha particles through gold foil. For the point, give the last name of Ernest, who discovered the atomic nucleus.

ANSWER: Rutherford (accept Daniel Rutherford; accept Ernest Rutherford)

Replacements

(Tossup 31) The concentration of an allotrope of this element is measured in Dobson units. Cyanobacteria contribute to a rapid increase in levels of this element in a namesake “great event.” This element was called “dephlogisticated air” by Joseph Priestley. For the point, name this element present in ozone.

ANSWER: oxygen

(Tossup 32) Endosomes fuse with these organelles and deliver mannose-6-phosphate receptors carrying hydrolases. Enzyme mutations lead to “storage” disorders in these organelles like Tay-Sachs disease. Enzymes in this organelle work best at a very low pH. For the point, name this organelle that digests macromolecules and cellular waste.

ANSWER: Lysosome