Round 3

Round 3 Tossups

(1) One visual structure formed by this effect has its size defined by the Einstein radius. This effect, which causes Einstein rings, is caused by dark matter in the Bullet Cluster. In a proof of general relativity, this effect was observed via the change of a star's position during a solar eclipse. This effect can cause copies of quasars to appear in an Einstein Cross. For the point, name this effect in which the force of gravity bends light.

ANSWER: Gravitational **lens**ing (accept micro, weak, or strong **lens**ing)

(2) The air required for these devices to operate is called draught [[DRAFT]] and can be pulled in through the convective action of chimneys. When used as part of a home heating system, these devices are linked to hollow metal tubes called radiators by insulated pipes. The fire-tube type of these devices were historically used to provide energy for steam engine trains. For the point, name these devices that heat pressurized water to provide steam to drive an engine.

ANSWER: **Boiler** (accept Fire-tube **boiler**)

(3) The Mazon Creek fossil beds in Illinois are primarily made up of this rock. This rock is distinguished from marl by lacking conchoidal [[kon-KOY-dul]] fractures and from mudstone by being highly fissile. Kerogen [[KEH-roh-jen]] hydrocarbons can be found in deposits of this rock. Along with dolomite [[DOH-loh-"might"]], this rock makes up the Bakken [[BAH-ken]] Formation. For the point, name this flaky sedimentary rock that often includes oil deposits such as at places named Burgess in Alberta.

ANSWER: **Shale** (accept Burgess **shale**)

(4) The primary task of the Pierre Auger [[oh-ZHAY]] Observatory is observing and tracing the origins of these phenomena. When composed of heavy elements, these phenomena are called HZE ions. Theoretically, the upper energy limit of these phenomena when traveling through the intergalactic medium is set by the G-Z-K limit. Upon making contact with the atmosphere, these phenomena create a cascade of ionized particles known as an air shower. For the point, name these extremely high energy particles named for primarily originating outside the solar system.

ANSWER: **Cosmic** rays

(5) Regular expressions are used to match this type of data, and in C, these objects are stored in arrays ending with a null terminator. In Java, the plus sign can be used to concatenate [[kon-KAT-eh-nate]] objects of this type. Often constructed using double quotes, for the point, what is this data type which is comprised of sequences of characters and is used to store text?

ANSWER: **String** (prompt on "str"; prompt on “barchar”; prompt on "text" before mentioned)

(6) In *Selenomonas* [[seh-lee-no-MOH-nuss]], these structures can wrap around each other to form a fascicle [[FASS-ih-kul]]. In other bacteria, these structures are anchored with a thin, helical "hook" and a basal body. Unlike those found in bacteria and archaea [[ar-KAY-uh]], examples of these structures in eukaryotes [[yoo-KEH-ree-"oats"]] contain dynein [["DIE"-neen]] or microtubules. The "whip-like" motion of these structures allows bacteria to move toward food. For the point, name these locomotive cell components, which are larger than cilia [[SIH-lee-uh]].

ANSWER: **Flagella** [[flah-JEH-lah]] (or **Flagellum**)

(7) Troughs between these structures are known as their namesake "slack." These structures are known as zibars [[ZEE-bars]] when they lack a slip face. Multidirectional winds lead to the formation of the "star" type of these structures. Wind primarily from one direction forms the crescent-shaped barchan variety of these structures. Flat, wind-swept areas covered in these structures are known as ergs. For the point, name these hills made of particulate matter, commonly found at beaches and deserts.

ANSWER: Sand **Dune**s (accept **Dune** System; or **Dune** Complex; or **Dune** Field)

(8) A Knudsen cell is used to measure this quantity for a solid, which can then be used to find its enthalpy of sublimation via the Clausius-Clapeyron [[klah-peh-ROHN]] relation. Volatile substances have high values for this quantity, which is multiplied by the mole fraction to give the partial pressure of a substance according to Raoult's [[ra-OOLZ]] law. A substance boils when this quantity equals the atmospheric pressure. For the point, name this quantity, the force per unit area exerted by a gas in equilibrium with its liquid phase.

ANSWER: **Vapor Pressure** (accept Equilibrium **Vapor Pressure**; prompt on "pressure")

(9) The generation of these bonds uses protecting groups such as Fmoc [[F-M-O-C]] and Boc [[B-O-C]] in a type of solid phase synthesis. E3 ubiquitin [[yoo-BIH-kwih-tin]] ligases [["LIE"-gay-ses]] catalyze the formation of the "iso-" type of these bonds, whose phi and psi [["SIGH"]] dihedral angles can be visualized on a Ramachandran [[RAH-mah-CHAHN-drun]] plot. Pepsin and chymotrypsin [[kai-moh-TRIP-sin]] cleave these bonds, which are formed from the reaction of a carboxyl group with an amine at the P site of the ribosome. For the point, name these bonds that form between adjacent amino acids in a protein.

ANSWER: **Peptide** bond(s) (accept Eu**peptide** bond(s); accept Iso**peptide** bond(s); prompt on "covalent" bond(s); prompt on "amide" bond(s))

(10) Herodotus credited this mathematician, who was nicknamed "Beta" among his peers, with inventing the first armillary [[AR-mih-lay-ree]] sphere. A method developed by this mathematician involves deleting all multiples of each remaining number starting with two. Using the distance between Syene [["sigh"-EEN]] and Alexandria, this mathematician gave the first estimate of Earth's circumference. For the point, name this mathematician whose namesake "sieve" can be used to find prime numbers.

ANSWER: **Eratosthenes** [[eh-rah-TAHS-theh-neez]] of Cyrene

(11) The Thysville Cave system along this river is the only known habitat of this river's namesake "blind barb" fish. This river's basin is the endemic range of the *Hydrocynus goliath*, or giant tigerfish. The dwarf crocodile and African manatee both inhabit this river, and the formation of this river is believed to have caused the divergent speciation of chimpanzees and bonobos. For the point, name this species-rich Central African river that flows past Brazzaville and Kinshasa.

ANSWER: **Congo** River (or Nzâdi **Kôngo**; accept **Congo** blind barb)

(12) This technique is performed at 800 degrees Celsius to industrially produce sodium metal in a Downs cell. This technique is applied to a bath of molten cryolite to smelt aluminum in the Hall-Heroult [[heh-ROH]] process. Michael Faraday proposed two laws to describe the mass added onto electrodes during this process, which is also used to split water into hydrogen and oxygen gas. For the point, name this process that uses an electrical current to drive a non-spontaneous chemical reaction.

ANSWER: **Electrolysis** (accept **Electrolytic** process; accept **Electrorefining**; accept **Electrowinning**; accept **Electroplating**; prompt on "Electrochemical process")

(13) The telescope camera *Ralph* was the primary camera device on this probe. This probe carried a spectrometer named *Alice* which confirmed the discovery of a "wall" of hydrogen first made by the Voyager probes. Images captured by this probe led to the discovery of the moons Kerberos [[KER-ber-ohss]] and Styx. For the point, name this probe that studies objects in the Kuiper Belt, which flew past the Pluto system in 2015.

ANSWER: **New Horizons**

(14) The pesticides AzaGuard and Starycide work by preventing this process, making them a type of IGR pesticide. Some invertebrates undergo this process when the corpus allatum [[ah-LAH-tum]] stimulates the production of juvenile hormone, inducing ecdysis [[EK-dih-sis]]. Hemi-metabolous insects undergo an incomplete form of this process that involves an immature nymph stage. Butterflies and moths have an intermediate stage in this process called a chrysalis [[KRIH-sah-lis]] or cocoon. For the point, name this process by which insects mature, such as when caterpillars become butterflies.

ANSWER: **Metamorphosis** (prompt on "maturation" or similar answers)

(15) Elements in this group release solvated electrons and appear blue when dissolved in ammonia. Cyclic "crown" ethers are used as phase transfer catalysts because they bind ions of elements in this group. The least electronegative elements are found in this group, whose members react violently with water to produce hydrogen gas. For the point, name this group found at the far left of the periodic table, which includes cesium, lithium, and sodium.

ANSWER: **Alkali** metals (or Group **1**; or Group **1A**; or **Lithium** group or family; do not accept or prompt on "alkaline" or "alkaline earth")

(16) When computing this quantity for a galaxy from its luminosity, this quantity must be multiplied by ten to account for dark matter. The gravitational force between two objects equals big G over r squared times this quantity for both objects, and the standard unit of this quantity in astronomy is the “solar” one. For the point, name this quantity equal to a star’s density times its volume, for which the sun is around two times ten to the 30th kilograms.

ANSWER: **Mass** (accept Galactic **mass**)

(17) This nutrient inhibits smooth muscle growth by deactivating protein kinase C [[KAI-nase-see]]. Mutations to the a-tocopherol [[ay-toh-KAH-feh-rahl]] transfer protein encoding gene causes this nutrient's familial isolated deficiency. Dietary supplements for this nutrient esterify tocopherols to form this vitamin's acetate [[AH-seh-tate]]. This vitamin is commonly used in skincare products that allegedly prevent aging or drying. This vitamin is found in plant oils and possesses antioxidant properties. For the point, name this fat soluble vitamin important for protecting the cell membrane from ROS species.

ANSWER: Vitamin **E**

(18) This thinker is the first listed in the title of a Douglas Hofstadter book subtitled "An Eternal Golden Braid." This thinker's best known result was published in response to Russell and Whitehead's *Principia Mathematica*, and in it this man showed that their project was impossible to complete. One of this thinker's theorems states that no field can be used to prove its own consistency. For the point, name this German-American mathematician and logician, who proved all mathematical fields will have true but unprovable results in his incompleteness theorem. .

ANSWER: Kurt **Gödel** [[GUR-dul]] (accept ***Gödel****, Escher, Bach: an Eternal Golden Braid*; accept **Gödel**'s incompleteness theorem(s))

(19) Extended fatigue following an instance of this condition is Sopite [[SOH-pite]] syndrome. According to the nystagmus [[nih-STAG-muss]] hypothesis, this condition is caused by vagus [[VAY-gus]] nerve stimulation. One type of this condition caused by the body mistakenly believing that a hallucinogenic toxin has been ingested can be induced by virtual reality technology. This condition is caused by mixed signals between the vestibular [[veh-STIH-byoo-lar]] and visual systems. For the point, name this condition treated with Dramamine, characterized by nausea induced due to differences between actual and perceived movement.

ANSWER: **Motion sick**ness (or **Car sick**ness; or **Sea sick**ness; or **Air sick**ness; prompt on "nausea" or "dizziness")

(20) Acids containing this element react with halides in the Suzuki coupling reaction. A compound of this element and hydrogen contains 3-center 2-electron "banana" bonds as predicted by Wade's rules. The ores colemanite and ulexite [[OO-lek-site]] contain this element, whose trifluoride is a strong Lewis acid with only six valence electrons, which unusually violates the octet rule. For the point, name this element with atomic number 5 and chemical symbol "B."

ANSWER: **Boron** (accept **B** before mentioned)

(21) With Duhem [[doo-EM]], this scientist names a formula that determines the relationship between changes in chemical potential for a thermodynamic system. With James Clerk [[CLARK]] Maxwell and Ludwig Boltzmann, this scientist developed and coined the name of statistical mechanics. For the point, name this American physicist who lends his name to a type of free energy that decreases in spontaneous reactions.

ANSWER: Josiah Willard **Gibbs** (accept **Gibbs** free energy or **Gibbs** energy; accept **Gibbs**-Duhem equation)

(22) One form of this technique uses firefly luciferase [[LOO-sih-feh-"race"]] to detect released pyrophosphate ions, which can be coupled with bisulfite [[bai-SUL-"fight"]] treatment to detect methyl groups at CpG islands. A flow cell with clustered primers is used in a "next-generation" type of this technique developed by Illumina. Fluorescent dideoxynucleotides [["die"-dee-ahk-see-NOO-klee-oh-"tides"]] cause a growing chain to terminate in a form of this technique pioneered by Frederick Sanger. For the point, name this technique that determines the order of bases in a sample of DNA.

ANSWER: DNA **sequencing**

(23) This geological period's Bonarelli Event, a period of ocean anoxia, started this period's namesake "Thermal Maximum". This period saw Earth's last superchron and the formation of the Western Interior Seaway. The adaptive radiation of angiosperms began in this period, whose end is marked by a global layer of iridium in the crust. For the point, name this final period of the Mesozoic Era, whose end likely occurred due to a meteor impact off the Yucatan Peninsula.

ANSWER: **Cretaceous** period

(24) In a book titled for [This Man] *and His Modern Rivals*, Lewis Carroll claimed that all subsequent mathematicians have only restated this man's ideas. This man names a mathematical operation also known as division with remainder. This man names a field of geometry that assumes a set of theorems before deducing further propositions. For the point, name this ancient Greek mathematician and geometer, the author of thirteen theorems presented in his *Elements*.

ANSWER: **Euclid** of Alexandria (accept **Euclid**ean division; accept **Euclid**ean geometry)

(25) During this process, calcium and magnesium ion-dependent endonucleases [[en-doh-NOO-klee-ay-ses]] initiate karyorrhexis [["care"-ee-or-EK-sis]], spreading chromatin [[KROH-mah-tin]] through the cell. During this process, the proteins Bak [["BACK"]] and Bax [[BAKS]] trigger the release of cytochrome C from the mitochondria. The intrinsic type of this process can be initiated by the accumulation of the tumor suppressor protein p53, which is produced when DNA is irreparably damaged. For the point, name this process of programmed cell death.

ANSWER: **Apoptosis** (prompt on "Programmed Cell Death" or "Cell Death" before mentioned)

(26) The namesake radiation curve of these systems have peaks inverse to temperature according to Wien's [[VEENS]] displacement law. These systems have spectrums dependent entirely on energy level and not composition or shape. The radiation emission of these systems is described by Planck's law. These hypothetical systems would be both ideal and diffuse emitters. For the point, name these idealized objects that absorb all incoming radiation.

ANSWER: **Black Body**

(27) This region is responsible for observed P wave speed anisotropies [[an-ih-SAH-troh-peez]] at its lower boundary. This region creates "shadow zones" by fully stopping S waves and slowing P waves. The upper boundary of this region is the Gutenberg discontinuity. Convection in this region is responsible for the Earth's magnetic field according to the geodynamo theory. For the point, name this liquid layer of the Earth which surrounds the inner core.

ANSWER: **Outer core** (prompt on "core")

(28) Power transmitted by these devices is equal to the difference in tension times velocity. When notched to be able to track movement, these devices are known as their timing or toothed type. The "V" type of these devices lock into groves on the pulley, preventing slippage. These devices are used to provide the energy for a washer and dryer to rotate, as well as to transmit energy in a car from the crankshaft. For the point, name these continuous loops of material that link multiple rotating shafts, whose "conveyor" type are used to move objects in factories.

ANSWER: **Belt** (prompt on "chain" or "rope"; accept Timing **belt**; accept Toothed **belt**; accept V-**belt**; accept Conveyor **belt**)

(29) This quantity is conserved due to rotational invariance according to Noether's [[NOH-thers]] theorem. The rate of change in this quantity is equal to torque. The conservation of this quantity is illustrated by a spinning skater pulling in their arms to rotate faster. Spin is the intrinsic form of this quantity in a particle. For the point, name this physical quantity equal to mass times radius times velocity.

ANSWER: **Angular Momentum** (accept **Moment of momentum** or **Rotational momentum**; prompt on "momentum"; do not accept or prompt on "Linear Momentum")

(30) When two of these objects merge, a kilanova occurs. These objects exist above the Chandrasekar [[chahn-drah-SEH-kar]] limit and below the Tolman-Oppenheimer-Volkoff limit. When these objects are aligned with the Earth, they are perceived as pulsars. Like White Dwarfs, these objects are supported by the degeneracy pressure of their namesake constituent particles. For the point, name these extremely dense objects that are made up of uncharged baryons.

ANSWER: **Neutron star**s (accept **Pulsar**s before mentioned)

(31) This element's oxide was historically known as "philosopher's wool" when made by alchemist's burning this element in the air. Over 95 percent of this element used in the world is extracted from sphalerite [[SFAH-ler-ite]], an ore formed from this element, iron, and sulfur. Steel can be protected from corrosion by galvanizing it with a layer of this element. For the point, name this metal that forms brass with copper, supplements of which have been shown to reduce the duration of common cold symptoms.

ANSWER: **Zinc** (or **Zn**)

(32) Leptons carry a positive or negative one-half value for this force's isospin. Different effects of this force on matter and antimatter demonstrates CP violation. The 1979 Nobel Prize in Physics was awarded for demonstrations that at high energies this force is indistinguishable from electromagnetism. This force is mediated by W and Z bosons. For the point, name this force that governs beta decay, which is named for being less powerful than the strong force.

ANSWER: **Weak** Force (or **Weak** Interaction; or **Weak** Nuclear Force; accept Electro**weak** Theory or **EWT**)

(33) Phosgene [[FAHS-jeen]] is produced by reacting this molecule with chlorine gas. Steam reforming releases both hydrogen gas and this molecule, a mixture which is known as Syngas. This molecule is isoelectronic with the cyanide ion and gaseous nitrogen. Incomplete combustion reactions release this diatomic [["die"-ah-TAH-mik]] molecule, whose toxicity is explained by the fact that it binds hemoglobin with 200 times the affinity of oxygen. For the point, name this gas found in vehicle exhaust, with formula CO [[SEE-OH]].

ANSWER: **Carbon Monoxide** (accept **CO** before mentioned; do not accept or prompt on "carbon dioxide")

(34) The mass of this particle requires that it decay into a bottom and anti-bottom quark a majority of the time. The existence of these particles causes spontaneous electroweak symmetry breaking. Because this particle has a spin of zero, it is scalar rather than gauge. A 1993 book by Leon Lederman is the origin of this particle's popular nickname, the "God particle." For the point, name this particle discovered in 2012 at CERN, the carrier particle of mass.

ANSWER: **Higgs** Boson (or **Higgs** Particle; prompt on "God Particle" before mentioned)

(35) These crops are the most notable to be engineered to express a jellyfish's green fluorescent protein as an aid to reducing water usage. Like tomatoes, this crop can be destroyed by infections of the water mold *Phytophthora infestans* [[fai-TOFF-theh-rah in-FES-tans]]. This crop in the nightshade family was originally from Peru and has the scientific name *Solanum tuberosum* [[so-LAH-noom too-beh-ROH-soom]]. Including fingerling, gold, and russet varieties, for the point, what are these tubers that are often mashed or baked?

ANSWER: **Potato**es (accept specific types of **potato**es such as those mentioned; accept ***Solanum tuberosum*** before mentioned)

Extra Question

(1) This inventor was inspired by a wine glass instrument played by Edward Delaval [[deh-lah-VAHL]] to build the modern glass harmonica. This inventor created the hand paddle swimming aid and was the first to chart the course of the Gulf Stream by dropping bottles into the ocean. For the point, name this inventor of a namesake heating stove and bifocals, an American Founding Father who may have tied a key to a kite to prove that lightning was electricity.

ANSWER: Benjamin **Franklin**