Round 4

Round 4 Tossups

(1) This molecule's relative stability is quantified by A-values. One conformation of this molecule is destabilized by steric strain between its "flagpole hydrogens." Substituents on this nonpolar molecule switch between "axial" and "equatorial" positions when it undergoes a ring flip to move between its twist, boat, and chair conformations. Complete hydrogenation of benzene produces, for the point, what cyclic alkane with formula C6H12?

ANSWER: **Cyclohexane** (accept **C6H12** before mentioned)

(2) This object is considered by astronomers as the best with which to calibrate the period-luminosity relationship of Cepheid [[SEE-fee-id]] variables. This object is the prototype of a galaxy classification with one major spiral arm. This galaxy's Tarantula Nebula contains the remnants of Supernova 1987A. A bridge of neutral hydrogen connects this galaxy to its smaller counterpart. For the point, name this bigger of two Local Group galaxies named after a Portuguese explorer.

ANSWER: **Large Magellanic Cloud** (or **LMC**; do not accept or prompt on partial answers, or "Small Magellanic Cloud" or "SMC")

(3) The third book of this text, *On the system of the world*, expands on the scientific method in its four "Rules of Reasoning in Philosophy." The essay *General Scholium* [[SKO-lee-oom]] was added to this text and includes the statement "Hypotheses non fingo." This text contains mathematical derivations of Kepler's laws and a statement that a change in motion is proportional to the net force. For the point, in what text does Isaac Newton describe his three laws of motion?

ANSWER: *Philosophiae Naturalis* ***Principia*** *Mathematica* (prompt on "PM")

(4) This equation is modified to give the Kassirer-Bleich [[kah-SEER-er BLYSH]] equation, which is used clinically to diagnose respiratory alkalosis [[al-kah-LOH-sis]]. The Hammett function must be used instead of this equation in highly concentrated solutions. The isoelectric point of an amino acid is calculated using this equation, which is derived by taking the log of the acid dissociation constant and rearranging. The pH of a buffer solution can be calculated using, for the point, what equation named for two scientists, one American and one Danish?

ANSWER: **Henderson-Hasselbalch** equation (accept names in either order)

(5) A model of this process relates an ideal gas's fractional occupancy to its partial pressure at isothermal conditions and is named for Irving Langmuir [[LANG-mweer]]. Heterogeneous catalysts function through this process. Because of their high surface area, porous materials like zeolites and activated carbon use this process to remove compounds from the air. For the point, name this process in which molecules adhere to a solid surface but do not permeate through, which is contrasted with absorption.

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

(6) The discovery of one of these objects in the Gliese [[GLEE-zuh]] system proved the existence of the T-type of these objects. The closest one of these objects to Earth is the Luhman-16 system, which is also where the iron rain of these objects was first observed. Rafael Rebolo [[reh-BOH-loh]] pioneered the lithium test for identifying these bodies, which do not undergo sustained hydrogen fusion. For the point, name these cool, very low luminosity stellar objects, commonly called failed stars.

ANSWER: **Brown dwarf**s (prompt on "star(s)")

(7) The potential energy of these devices can be approximated with the second-order cosine approximation. The momentum of a bullet can be found by firing a gun into the ballistic variety of these devices. A classical example of a chaotic system is the double variety of these devices. The ideal form of these devices consists of a weighted bob at the end of a massless rod. For the point, name these devices that swing to keep time in grandfather clocks.

ANSWER: **Pendulum**s

(8) This is the number of carboxylic acid groups found in the common chelating [[KEE-lay-ting]] agent EDTA. This many carbon atoms are found in the simplest antiaromatic molecule, cyclobutadiene [["sigh"-kloh-byoo-tah-"DIE"-een]]. Steroids such as cholesterol contain this many fused rings, which is also the number of bonds to the central atom in molecules with see-saw and square planar geometries. For the point, give this number of hydrogen atoms found in methane, the simplest tetrahedral alkane.

ANSWER: **Four**

(9) A saturable reactor type of these devices may be used to increase maximum alternating current. The number of turns in these devices divided by length is directly proportional to their magnetic flux density. These devices are typically constructed out of an insulated wire coil and store energy in the magnetic field when passing an electric current through it. For the point, name these circuit components whose namesake quantity is measured in Henrys.

ANSWER: **Inductor**s (accept **Coil**, **Choke**, or **Reactor**)

(10) In the FLRW metric, this quantity is equal to a generalized cosmological constant symbolized "minus P C squared." The integrated Sachs-Wolfe effect is caused by the influence of this quantity. The existence of an increasing variety of this quantity, known as its phantom type, would cause the "big rip" end of the universe. For the point, name this unobserved quantity that drives the expansion of the universe and makes up the bulk of the universe's mass-energy, more than twice as prevalent as dark matter.

ANSWER: **Dark energy** (do not accept or prompt on "dark matter")

(11) Modern measurements of this value use X-ray diffraction to quantify unit cell volumes in a silicon crystal lattice. Faraday's constant equals the charge of an electron times this quantity, which is also multiplied by Boltzmann's constant to give the ideal gas constant. This constant equals the number of atoms in 12 grams of carbon-12, which is approximately 6.022 times 10 to the 23rd power. For the point, name this constant that defines the number of particles in a mole, named for an Italian scientist.

ANSWER: **Avogadro**'s number (or **Avogadro**'s constant)

(12) This hormone names a secretagogue [[see-KREH-tah-gog]] receptor 1A, which is activated by Ghrelin. Crowded teeth and enlarged hands and feet are common symptoms of a disorder caused by this hormone. Excessive levels of this hormone can cause pituitary tumors and acromegaly [[ak-roh-MEH-gah-lee]]. Deficiencies of this hormone are the primary cause of human dwarfism. For the point, name this common performance-enhancing drug, a peptide hormone responsible for stimulating cell division.

ANSWER: Human **Growth Hormone** (or H**GH**; accept **Somatropin** or **Somatotropin**)

(13) Sodium content in this rock is the basis of the S-I [["S"-"EYE"]] classification. This rock, the intrusive counterpart of rhyolite, is the most common material found in Bornhardts. This rock forms its namesake domes at landmarks such as Sugarloaf Mountain and Yosemite's Half Dome. This rock contains crystals of feldspar and quartz and predominantly makes up the continental crust. For the point, name this coarse grained igneous rock commonly used to make high end countertops.

ANSWER: **Granite**

(14) High speed optical communication using this radiation relies on the C band of EDFAs. Along with ambient visible light, this is the primary radiation converted into electrons in night vision goggles. This radiation names a form of spectroscopy that measures a molecule's vibrational transition. This radiation has wavelengths from 700 millimeters to one centimeter. For the point, name this radiation range with wavelengths longer than that of visible light.

ANSWER: **Infrared** light (or **IR**)

(15) While working at St. Thomas's Abbey, this scientist was prevented from studying mouse reproduction by the local bishop. This scientist's paper "Experiments on Plant Hybridization" led to the introduction of the laws of segregation and independent assortment. This scientist's studies of *Pisum sativum* [[PEE-soom sah-TEE-voom]] led him to coin the terms "dominant" and "recessive." For the point, name this 19th-century friar who studied inheritance among pea plants.

ANSWER: Gregor Johann **Mendel**

(16) One of these events in Lituya Bay, Alaska caused the largest ever measured mega-tsunami. Increases in pore pressure and hydrostatic pressure in surface cracks are common causes of these events. The field of predicting these events is called slope stability analysis. These events, which are a form of mass wasting, are often preceded by heavy rains destabilizing the surface layer. For the point, name these potentially catastrophic movements of rock and sediment down a slope.

ANSWER: **Mudslide**s (accept **Landslide**s; accept **Mudflow**s; accept **Rockslide**s; accept **Flow Slide**s; prompt on "mass wasting" before mentioned)

(17) Bourdon [[boor-DOHN]] tubes utilize coil expansion due to this law to measure pressure. Stress-strain curves have straight lines due to this law. This law can be generalized as strain is proportional to stress in elastic materials. This law predicts that distance from equilibrium is negatively and directly proportional to the restoring force. For the point, name this law relating force to displacement, which models the behavior of springs as "F equals negative kx."

ANSWER: **Hooke**'s law

(18) This compound was first popularized due to pyrethrum [[pai-REE-thrum]] shortages. Up-regulation of cytochrome P450 conveys resistance to this organo-chlorine compound, which prevents sodium channels from closing. This chemical was implicated in declining peregrine falcon and bald eagle populations as it accumulated in their prey. For the point, name this pesticide that was largely banned following the revelation that it thinned eggshells after the release of Rachel Carson's *Silent Spring*.

ANSWER: **DDT** (or **Dichlorodiphenyltrichloroethane**)

(19) This material is produced using epitaxy [[EH-pih-tak-see]] by growing it on layers of silicon carbide in a form of chemical vapor deposition. This material exhibits an unusual half-integer form of the quantum Hall effect. Each atom in this material shares three sp2 hybridized orbitals, making it the strongest of all currently known materials. Andre Geim [[GIME]] employed micromechanical exfoliation and a silicon wafer to isolate layers of this material using Scotch tape and the primary component of pencil lead. For the point, name this 2D carbon allotrope arranged in a single-layered hexagonal lattice.

ANSWER: **Graphene** (prompt on "Carbon Nanotubes"; do not accept or prompt on "graphite")

(20) In systems with mass addition, this law is modified to include "U naught equals Usub1 plus Usub2." This law is extended to the enthalpy of a chemical reaction by Hess's law. This law, which is often notated as "delta U equals Q minus W," is equivalent to stating that first kind perpetual motion machines are impossible. For the point, name this law that states that the total amount of mass-energy in a system is constant.

ANSWER: **First Law** of **Thermodynamics** (prompt on "Conservation of Energy"; prompt on partial answers)

(21) Swedish engineer Hannes Alfvén [[HAH-ness AL-fee-yen]] said that the prerequisites for carrying out this task include stable geological formations and governments over thousands of years. One controversial method for carrying out this task involves depositing a certain substance into a subduction zone. The primary method for carrying out this task is called deep geological repository. For the point, identify this task of safely dealing with the waste products of fusion and fission.

ANSWER: **Radioactive waste disposal** (accept any answer indicating the disposal, storage, or management of waste products from nuclear power plants or weapons)

(22) In *The Analyst*, George Berkeley [[BAR-klee]] used an error involving this value in his critique of fluxions [[FLUK-shuns]] and infinitesimals, providing an example of "ghosts of departed quantities." This value represents the Turing degree of the partial computable functions. This value represents the bottom element of a bound lattice and is the cardinality of the empty set. For the point, name this number that creates an undefined expression as the denominator of a fraction.

ANSWER: **Zero** (accept **Naught** or **Nil**)

(23) This species's O157:H7 [[OH-157-H-7]] and O104:H4 [[OH-104-H-4]] serotypes [[SEE-roh-"types"]] are the most common cause of hemolytic-uremic [[hee-moh-LIH-tik-yoo-REE-mik]] syndrome by releasing Shiga [[SHEE-gah]] toxins. Lenski et al.'s ongoing evolution experiment with this species observed them spontaneously developing the ability to metabolize citrate [[SIT-"rate"]]. In humans, beneficial strains of this species are involved in producing vitamin K in the intestines. For the point, name this rod-shaped gram negative gut bacteria, a common model organism.

ANSWER: **E. coli** (or **E**scherichia **coli**)

(24) This location contains the highly saline Barsakelmes [[BAR-sah-KEL-mess]] Lake. This location is the origin of toxic dust storms that spread tuberculosis and cause cancer in former fishing towns such as Mo'ynoq [[MOY-nok]]. Desertification of this location was driven by agricultural diversion of the Syr Darya and Amu Darya rivers. For the point, name this now mostly dried up Central Asian lake, formerly located on the border of Kazakhstan and Uzbekistan.

ANSWER: **Aral** Seabed (or **Aral** Sea; accept **Aralkum** Desert)

(25) Practitioners of this field who reject scientific induction in favor of vitalist dogma are called "straights," as contrasted with "mixers." This field was founded and developed by the father-son pair D.D. and B.J. Palmer. This field was founded on pseudo-scientific claims of the existence of lesions not visible on X-rays, termed vertebral subluxations [[sub-luk-SAY-shuns]]. For the point, name this field of alternative medicine based around performing spinal "alignments."

ANSWER: **Chiropractic** (accept word forms like **Chiropractor**)

(26) In this country, an arena representing the Sun forms part of the world's largest scale model of the Solar System. The author of *Systema Naturae* [[NAH-tyoo-ray]] was from this country. A village in this country is the namesake of four chemical elements, including Ytterbium [[ee-TER-bee-um]]. The home country of Svante Arrhenius [[SVAHN-teh ah-REE-nee-us]] and Arvid Carlsson, for the point, what is this country in which the presentation ceremonies of all three science Nobel Prizes are held?

ANSWER: Kingdom of **Sweden** (or Konungariket **Sverige**)

(27) One paradigm used in this language replaced dataframes and tables with tibbles. That paradigm in this language uses ggplot2 [[G-G-PLOT-TWO]] and dplyr [[DEE-ply-er]] and is known as the tidyverse. Stable packages used in this language can be hosted by CRAN. This language is most commonly implemented in an Integrated Development Environment called [this language] "Studio." For the point, name this open source programming language primarily used for data and statistical analysis.

ANSWER: **R** (accept **R**Studio)

(28) This scientist countered Hoyle's Fallacy, which proposed a tornado in a junkyard assembling a jet, by describing a complex god as the "ultimate Boeing 747." This scientist described cultural features that are passed down in a way analogous to genes with the coined term "meme." This scientist popularized the gene-centered view of evolution in books such as *River Out of Eden* and *The Selfish Gene*. For the point, name this British evolutionary biologist, known for his criticisms of religion in his book *The God Delusion*.

ANSWER: Richard **Dawkins**

(29) Cancer of this organ is associated with the formation of a so-called "porcelain" on the walls of this organ by deposited calcium. This organ can be affected by cholesterolosis [[koh-leh-steh-RAH-loh-sis]], which is also known as "strawberry" [this organ]. This organ can be removed when it accumulates painful amounts of calcium salts and cholesterol, forming this organ's namesake stones. For the point, name this organ that receives and stores bile from the liver.

ANSWER: **Gallbladder** (accept **Cholecyst**)

(30) This value is the same for all variables in a homoscedastic [[ho-mo-skee-DAS-tik]] data set. Bartlett's test, a type of F-test, compares two values for this quantity, which is also analyzed by a set of models developed by Ronald Fisher called ANOVA [[ah-NO-vah]]. The parameter lambda for a Poisson [[pwa-SAHN]] distribution symbolizes both the expected value and this quantity, which is the square of the standard deviation. For the point, name this measure of how spread out a data set is.

ANSWER: **Variance** (accept Analysis of **variance**)

(31) This scientist controversially refused to give her subjects numbers, instead opting for names like "Goliath." This scientist observed one animal population using twigs and grass to "fish" for termites. This scientist observed a nonhuman "war" between the Kasakela and Kahama communities of Gombe [[GOHM-beh]] National Park. For the point, name this English anthropologist and primatologist, a woman best known for studying Tanzanian chimpanzees.

ANSWER: Jane **Goodall** (or Valerie Jane Morris-**Goodall**; or Baroness Jane van Lawick-**Goodall**)

(32) Since 2019, Huawei [[HWAH-WAY]] has been banned from implementing this technology in the U.S. due to espionage claims. This technology is the most recent standard developed by the 3rd Generation Partnership Project. Protestors in the UK who believed this technology was responsible for Covid-19 set fire to cell towers. The Samsung Galaxy S20 was the first smartphone compatible with this technology. For the point, name this latest broadband cellular standard.

ANSWER: **5G** NR (or **5G** New Radio]

(33) This feature was explored by the Victor Vescovo-piloted Ring of Fire expeditions. As part of Project Nekton, this feature was explored by the Auguste Piccard designed *Trieste* [[tree-ESS-teh]] vessel. One portion of this feature was explored by the *Kaiko* and *Nereus* unmanned submarines. This feature's southern end contains its deepest point, the Challenger Deep. Located near an American-controlled Pacific island group, for the point, what is this deepest point in the ocean?

ANSWER: **Mariana Trench** (or **Marianas Trench**; accept **Challenger Deep** before mentioned)

(34) Kruskal's and Prim's algorithms can be used to produce one of these data structures which connects all vertices of a graph with minimum edge weights. The red-black variety of this data structure is self-balancing, differentiating it from the binary search variety, and the first node of this structure is known as the root node. For the point, name this type of data structure whose terminal nodes are referred to as leaf nodes rather than branches.

ANSWER: **Tree** (accept Binary Search **Tree** before mentioned; accept Binary **tree**; prompt on "graph" before mentioned)

(35) Photoevaporation-driven mass loss prevents these objects from forming in the Fulton gap. The most common methods for detecting these objects include the radial velocity method and the transit method. When found in the habitable zone, these objects are said to be in the "goldilocks" zone. Examples of these objects include super-Earths and hot Jupiters. For the point, name these rocky or gaseous bodies that orbit stars other than our Sun.

ANSWER: **Exoplanet**s (accept any answer indicating extrasolar planets; accept answers such as planets outside our solar system; prompt on "planet"s)

Extra Question

(1) This man names a thought experiment about observing where objects land after being dropped from a ship's mast. This man's final book was a discourse on the study of motion and the study of materials titled *Two New Sciences*. The publication of this man's *Dialogue Concerning the Two Chief World Systems* led to him being condemned by the inquisition for his heliocentrism. For the point, name this scientist who observed a group of namesake moons of Jupiter.

ANSWER: **Galileo** Galilei (or Galileo **Galilei**)