BASIS PEORIA SCIENCE BOWL

DOUBLE ELIMINATION ROUND 5

TOSS-UP

1) Biology – *Short Answer* The thyroid gland produces the hormones T3 and T4. Both of these hormones play important roles in maintaining and regulating metabolism. Provide the names of T3 and T4, respectively.

ANSWER: Triiodothyronine and thyroxine

BONUS

1) Biology – *Short Answer* T4 acts as a precursor for T3, which is the active form of the hormone. This process involves removal of iodine from T4. Although this process occurs in multiple places throughout the body, what is the main organ that performs this reaction?

ANSWER: Liver

TOSS-UP

2) Chemistry – *Short Answer* Chemiluminescence is the emission of light by products formed in energetically excited states in a chemical reaction. In fireflies, what enzyme catalyzes the oxidation of luciferin to create chemiluminescence?

ANSWER: LUCIFERASE

BONUS

2) Chemistry – *Short Answer* In phosphorescence, electrons are exited from a singlet state to a triplet state. What electron property changes in this transition?

ANSWER: SPIN

TOSS-UP

3) Physics – *Multiple Choice* Which of the following has the highest sound velocity at 20 degrees Celsius?

W) Dry Air
X) Water
Y) Glass
Z) Wood

ANSWER: Y) GLASS

BONUS

3) Physics – *Short Answer* What is the term for a mechanical wave that propagates along the interface between differing media?

ANSWER: SURFACE WAVE

TOSS-UP

4) Math – *Short Answer* What mathematical operator, important in cryptography and often indicated by a percent sign, indicates the remainder when x is divided by y?

ANSWER: MODULUS

BONUS

4) Math – *Short Answer* What class of numbers is defined as all numbers n where n % x = 0 only when x = n or x = 1?

ANSWER: PRIME NUMBERS

TOSS-UP

5) Earth and Space – *Short Answer* What force holds up white dwarfs from gravitational collapse?

ANSWER: ELECTRON DEGENERACY PRESSURE (ACCEPT: PAULI EXCLUSION PRINCIPLE)

BONUS

5) Earth and Space – *Short Answer* What is the term for the maximum possible mass that a white dwarf can reach through accretion before going supernova?

ANSWER: CHANDRASEKHAR LIMIT

TOSS-UP

6) Energy – *Multiple Choice* Which of the following is an emission of E10 fuel?

W) Carbon Dioxide
X) Ethane
Y) Ozone
Z) Methane

ANSWER: Y) Ozone

BONUS

6) Energy – *Multiple Choice* Which of the following ethanol fuel mixtures is most common, and even mandated in some countries due to its low emissions?

W) E85
X) E5
Y) E100
Z) E10

ANSWER: Z) E10

TOSS-UP

7) Biology – *Short Answer* What vasodilator is released during an allergic reaction to activate the immune system?

ANSWER: Histamine

BONUS

7) Biology – *Short Answer* What rare disease occurs when an accumulation of mast cells results in increased histamine release? This disease causes a variety of different symptoms within the body, such as diarrhea and skin itches.

ANSWER: Mastocytosis

TOSS-UP

8) Chemistry – *Short Answer* Conductivity of materials is due to the energy gap between the valence band and what other energy band?

ANSWER: CONDUCTION BAND

BONUS

8) Chemistry – *Short Answer* Manganese is an interesting metal. In the presence of a magnetic field, the spins of neighboring electrons in the metal are locked into strictly antiparallel states. What is the name of this property, also exhibited by NiO.

ANSWER: ANTIFERROMAGNETISM

TOSS-UP

9) Physics – *Multiple Choice* Which of the following particles is second generation?

W) Tau neutrino

X) Electron
Y) Top quark
Z) Charm quark

ANSWER: Z) CHARM QUARK

BONUS

9) Physics – *Multiple Choice* Which of the following gauge bosons has not been experimentally proven to exist as of 2020?

W) Z boson
X) Graviton
Y) Photon
Z) Gluon

ANSWER: X) GRAVITON

TOSS-UP

10) Math – *Multiple Choice* Which of the following types of error is best summarized as "False Negative"?

W) Type I error
X) Type II error
Y) Type III error
Z) Null error

ANSWER: X) TYPE II ERROR

BONUS

10) Math – *Multiple Choice* Find the standard deviation of the data set (2, 3, 7). Give your answer in simplest radical form.

ANSWER: $\sqrt{\frac{14}{3}}$

TOSS-UP

11) Earth and Space – *Short Answer* What particles are created during the initial stages of a core-collapse supernova and are often detected hours before the light from that supernova?

ANSWER: NEUTRINOS

BONUS

11) Earth and Space – *Short Answer* What is the term for the maximum possible mass for the core of a stable star?

ANSWER: SCHONBERG-CHANDRASEKHAR LIMIT

TOSS-UP

12) Energy – *Multiple Choice* Which of the following types of fuel cells uses ceramic as its electrolyte?

W) Solid Oxide
X) Phosphoric Acid
Y) Alkaline
Z) Molten Carbonate

ANSWER: W) Solid Oxide

BONUS

12) Energy – *Short Answer* Solid oxide fuel cells can operate at temperatures upwards of 1000 degrees Celsius. Since these fuel cells can operate at such high temperatures, what metal will no longer be needed in the fuel cell?

ANSWER: Platinum

TOSS-UP

13) Biology – *Multiple Choice* Hematopoiesis is the complex process in which hematopoietic stem cells differentiate into various types of blood cells with different functions. Which of the following cells are precursors for platelets in this process?

W) Myeloblast
X) Megakaryocyte
Y) Common lymphoid progenitor
Z) Monocyte

ANSWER: X) Megakaryocyte

BONUS

13) Biology – *Short Answer* In hematopoiesis, myeloblasts act as precursors for four major groups of blood cells. Three of these groups are basophils, eosinophils, and neutrophils. What is the fourth group that myeloblasts give rise to?

ANSWER: Monocyte

TOSS-UP

14) Chemistry – *Short Answer* Chalcopyrite is a sulfide of a common transition metal found in +1 and +2 oxidation states. Name this pink conductive material with versatile uses in hardware, jewelry, and currency.

ANSWER: COPPER

BONUS

14) Chemistry – *Short Answer* Quantum dots are three dimensional clusters of semiconducting materials. They are often found to emit light and change the light they emit based on their diameter. One quantum dot has been used for tagging to cell membranes and contains a type II-IV, n-type semiconductor. Give the chemical formula for this common quantum dot.

ANSWER: CdSe

TOSS-UP

15) Physics – *Short Answer* What scientist was the first to derive Bernoulli's equation in its standard form?

ANSWER: LEONHARD EULER

BONUS

15) Physics – *Short Answer* List all of the following that are true about Bernoulli's principle: 1) Friction by viscous forces must be negligible for Bernoulli's equation to be true; 2) Bernoulli's principle can be derived from the principle of conservation of energy; 3) Bernoulli's principle can also be derived directly from Isaac Newton's First Law of Motion; 4) The principle is only applicable for isentropic flows; 5) Within a fluid flowing horizontally, the highest speed occurs where the pressure is highest.

ANSWER: 1, 2, 4

TOSS-UP

16) Math – *Multiple Choice* Which of the following theorems gives a sufficient condition for a function to be invertible in a neighborhood of a point in its domain?

W) Banach fixed-point theorem
X) Implicit function theorem
Y) Nash-Moser theorem
Z) Inverse function theorem

ANSWER: Z) INVERSE FUNCTION THEOREM

BONUS

16) Math – *Multiple Choice* Express the arc hyperbolic sine function in terms of the natural logarithm.

W)$ln(x + \sqrt{x^2 + 1})$
X)$ln(x + \sqrt{x^2 - 1})$
Y)$\frac{1}{2} ln(\frac{x+1}{x-1})$
Z)$\frac{1}{2} ln(\frac{1+x}{1-x})$

ANSWER: W)$ln(x + \sqrt{x^2 + 1})$

TOSS-UP

17) Earth and Space – *Short Answer* What is the name for the region around the Pacific Basin that experiences increased tectonic activity, such as earthquakes and volcanism?

ANSWER: RING OF FIRE

BONUS

17) Earth and Space – *Short Answer* What occurs when an earthquake shifts soil near the surface, causing water to seep into that soil and turning it into mud?

ANSWER: LIQUEFACTION

TOSS-UP

18) Energy – *Short Answer* Researchers at Brookhaven National Laboratory have found that when graphene is laid on soda-lime glass, the glass dopes the graphene. What element in the glass caused this doping?

ANSWER: Sodium

BONUS

18) Energy – *Multiple Choice* Which of the following elements is susceptible to doping

W) Lithium
X) Argon
Y) Fluorine
Z) Gallium

ANSWER: Z) Gallium

TOSS-UP

19) Biology – *Short Answer* HIV is a sexually - transmitted disease that attacks the cells of the body's immune system. What type of immune cells does HIV target?

ANSWER: T cells (Accept: CD4 cells or Helper T cells)

BONUS

19) Biology – *Short Answer* HIV specifically targets CD4 cells within the body, which are also known as helper T cells. Acquired Immunodeficiency Syndrome (AIDS) is diagnosed when the CD4 cell count drops below how many cells per cubic milliliter.

ANSWER: 200

TOSS-UP

20) Chemistry – *Short Answer* What functional group, found in acetic acid, has a carbon that is the combination of an alcohol and ketone? This group lowers the pKa of a hydrocarbon.

ANSWER: CARBOXYLIC ACID

BONUS

20) Chemistry – *Short Answer* Answer the following two questions about organic chemistry.

A) What functional group is represented by an oxygen connected to two alkyl or aryl groups?
B) What common solvent and anaesthetic contains the functional group identified in part A?

ANSWER: ETHER, DIETHYL ETHER

TOSS-UP

21) Physics – *Short Answer* What theorem states that the net electric force on the surface of a perfectly conducting spherically symmetrical shell is zero from any charge contained inside the shell?

ANSWER: SHELL THEOREM

BONUS

21) Physics – *Short Answer* In Gauss's Law, the electric flux in a Gaussian surface is equal to the enclosed charge divided by what constant?

ANSWER: VACUUM PERMITTIVITY (ACCEPT: PERMITTIVITY OF FREE SPACE OR ELECTRIC CONSTANT)

TOSS-UP

22) Math – *Short Answer* How many planes of symmetry does a tetrahedron have?

ANSWER: 6

BONUS

22) Math – *Short Answer* Rank all of the Platonic solids in order of increasing number of faces.

ANSWER: TETRAHEDRON, CUBE, OCTAHEDRON, DODECAHEDRON, ICOSAHEDRON

TOSS-UP

23) Earth and Space – *Multiple Choice* Which of the following minerals is classified as a sulfide?

W) Dolomite
X) Galena
Y) Corundum
Z) Barite

ANSWER: X) GALENA

BONUS

23) Earth and Space – *Short Answer* Rank the following 3 rocks from the smallest crystal size to the largest crystal size: 1: granite, 2: pegmatite, 3: rhyolite.

ANSWER: 3, 1, 2