Winter Science Bowl Tournament 2022-2023

Playoff Round 1

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TOSS-UP

1) Biology – *Short Answer* What is the name of the detergent-like substance released by type II alveolar cells to reduce cohesive forces between water on the surface of alveoli?

ANSWER: Pulmonary Surfactant (ACCEPT: Surfactant)
Written by: APLegends1#3363

BONUS

1) Biology – *Short Answer* Alice is studying the degradation of proteins and polypeptides via the 26S proteasome. She finds that enzymes are involved in the transportation of these proteins to the proteasome, as they catalyze the addition of what regulatory protein?

ANSWER: Ubiquitin

TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following structures forms when two glaciers merge together and a line of sediment is left between them?

W) Lateral Moraine
X) Cirque
Y) Drumlin
Z) Medial Moraine

ANSWER: Z) MEDIAL MORAINE [2, GEO] Eric

BONUS

2) Earth and Space – *Short Answer* What geologic province in the U.S. displays a namesake topography of parallel mountain chains formed by extensive normal faulting due to crustal extension?

ANSWER: BASIN AND RANGE PROVINCE (ACCEPT: BASIN AND RANGE) [3, GEO] Eric

TOSS-UP

3) Math – *Short Answer* $6/7^{ths}$ of the trees in the forest are tall trees. Of the tall trees in the forest, $3/11^{ths}$ are oak trees. If there are 36 oak trees, how many total trees are in the forest?

ANSWER: 154 [2, Alg] <Rak>

BONUS

3) Math – *Short Answer* How many maximums does the equation $3x^4-6x^2+3x+2$ have on the closed interval from -3 to 5?

ANSWER: 3 [3, Calc I] <Rak>

TOSS-UP

4) Physics – *Short Answer* How much current flows through a circuit composed of 2-ohm, 6-ohm, and another 6-ohm resistor connected in parallel with a 12V battery?

ANSWER: 10 A

BONUS

4) Physics – *Short Answer* Tony is playing on some very tall swings in the playground. Assuming he is in perfect harmonic motion and the angle of motion is negligible, if his highest point is 5m, and it takes 6 seconds to reach his highest point again, what is the length of the swing in meters to the nearest whole number?

ANSWER: 36

TOSS-UP

5) Chemistry – *Short Answer* Alice is currently studying a phenomenon within niobium alloys, which expel all magnetic flux when cooled below the critical temperature. What is the name of this phenomenon which ceases when the magnetic field becomes too strong?

ANSWER: Meissner Effect
Written by APLegends1#3363/Phys (Meisler/Superconductors)

BONUS

5) Chemistry – *Multiple Choice* Which of the following is INCORRECT regarding the Diels-Alder reaction?

W) High temperatures promote the Retro Diels-Alder reaction
X) A more substituted dienophile will lower the yield of the Diels-Alder reaction
Y) Diels-Alder reaction only occurs if the diene exists in its s-cis conformation
Z) The endo product is generally favored over the exclusive product in Diels-Alder

ANSWER: X) A more substituted dienophile will lower the yield of the Diels-Alder reaction
Written by APLegends1#3363/Org

TOSS-UP

6) Energy – *Multiple Choice* Ames National Laboratory is studying nanomaterials. The production of graphene relies on the closely-packed crystal structure of graphite for its outstanding elasticity and flexibility. Which of the following describes the crystal system of graphite?

W) orthorhombic
X) hexagonal
Y) tetragonal
Z) monoclinic

ANSWER: X) hexagonal

BONUS

6) Energy – *Short Answer* Brookhaven National Laboratory is developing heat sink components to optimize supercomputer performance. Order the following 3 materials by thermal conductivity at room temperature, from highest to lowest: 1) Aluminum; 2) Copper; 3) Diamond

ANSWER: 3 2 1

TOSS-UP

7) Biology – *Short Answer* What is the name of the central cavity of porifera, lined with flagellated choanocytes?

ANSWER: Spongocoel
Written by: APLegends1#3363

BONUS

7) Biology – *Short Answer* Identify all of the following 3 choices that are true regarding phyllotaxy.

1) Opposite is the most common phyllotaxy
2) Grasses exemplify a distichous phyllotaxy
3) Culver's Root exemplifies a whorled phyllotaxy

ANSWER: 2 AND 3 ONLY
Written by: APLegends1#3363

TOSS-UP

8) Earth and Space – *Short Answer* Which moon of Jupiter is thought to exhibit plate tectonics, in which slabs of ice subduct into its liquid mantle?

ANSWER: EUROPA [2, SPACE] Eric

Commented [1]: not sure if Europa is the only Jupiter moon, but specifying Galilean moon just makes it mc

BONUS

8) Earth and Space – *Short Answer* How many times greater is the luminosity of a 12 solar mass main-sequence star than a 3 solar mass main sequence star?

ANSWER: 128 [3, SPACE] Tony

TOSS-UP

9) Math – *Short Answer* For the polynomial $5x^2 - 3x + 9$, what is the value of the sum of its zeros divided by the product of its zeros?

ANSWER: ⅓ [2, Alg] <Rak>

BONUS

9) Math – *Short Answer* How many zeros are at the end of *60*! **[60 factorial]** ?

ANSWER: 14 [Number Theory] <spencerd>

TOSS-UP

10) Physics – *Short Answer* Consider a closed tube with a length of 21 centimeters. Assuming it's a perfect standing wave, what is the wavelength of the third overtone in centimeters?

ANSWER: 12

BONUS

10) Physics – *Short Answer* An object traveling under a constant acceleration of $8 m/s^2$ with an initial velocity of 8m/s. The object travels 60 meters after a certain amount of time. How long, in seconds, is the object in motion?

ANSWER: 3

TOSS-UP

11) Chemistry – *Short Answer* Identify all of the following 3 molecules that are aromatic: 1) Cyclooctatetraene **[cyclo-octo-tetra-ene]**; 2) Cyclobutadiene; 3) Cyclohexane

ANSWER: NONE
Written by APLegends1#3363/Org (Klein)

BONUS

11) Chemistry – *Short Answer* The hydrogenation of carbon-sulfide bonds in thioacetals can be catalyzed by what group of solid catalysts, which can also hydrogenate benzene but not esters?

ANSWER: Raney Nickel (ACCEPT: Nickel)
Written by APLegends1#3363/Org (Klein)

TOSS-UP

12) Energy – *Short Answer* Princeton Plasma Physics Laboratory studies quasiparticles. What term describes such collective excitations that can be modeled as quantized sound waves, similar to how photons are quantized light waves?

ANSWER: Phonons

BONUS

12) Energy – *Short Answer* Oak Ridge National Laboratory astronomers are studying the Blandford-Znajek **[Bland-ferd ZNAH-jek]** process, in which energy is extracted from a rotating black hole, which is thought to power quasars. In what region, located outside a black hole's event horizon, is this process thought to take place?

ANSWER: Ergosphere

TOSS-UP

13) Biology – *Multiple Choice* Which of the following is NOT a monilophyte?

W) Ferns
X) Horsetails
Y) Quillwort
Z) Moonworts

ANSWER: Y) Quillwort
Written by: APLegends1#3363

BONUS

13) Biology – *Short Answer* Identify all of the following 3 blotting techniques that are correctly associated with the structures they study. 1) Northern and RNA; 2) Western and Proteins; 3) Eastern and Post Translational Modifications.

ANSWER: ALL
Written by: APLegends1#3363

TOSS-UP

14) Earth and Space – *Short Answer* What highest-quality grade of coal is hard and shiny due to undergoing the most metamorphism?

ANSWER: ANTHRACITE [2, GEO] Eric

BONUS

14) Earth and Space – *Short Answer* What process is exemplified by sand grains bouncing along a surface as they are carried by wind, and by pebbles bouncing along the riverbed as they are carried by a stream?

ANSWER: SALTATION (ACCEPT: SALTATING)

TOSS-UP

15) Math – *Multiple Choice* A particle's position with respect to time in seconds is modeled by the equation $-t^4 + 5t^3/3 + 10t^2 - 25t + 10$ on the closed interval from 0 to 10. Which of the following is the 2nd time at which the particle comes to a stop?

W) $t = -\sqrt{5}$
X) $t = \sqrt{5}$
Y) t = 5/4
Z) t = -5/4
ANSWER: X) $t = \sqrt{5}$ [2, Calc] <Rak>

BONUS

15) Math – *Short Answer* a, b, and c are real numbers satisfying $a \cdot b \cdot c = 36$. What is the smallest possible value of $a + 2b + 3c$.
ANSWER: 18 [Algebra] <spencerd>

TOSS-UP

16) Physics – *Short Answer* Consider the circuit composed of a 12V battery, two 3 Ohm resistors connected in parallel, and a 12-Farad capacitor. To the nearest second, how long will it take for the capacitor to reach 63% of its full charge?

ANSWER: 18

BONUS

16) Physics – *Short Answer* Identify all of the following 4 particles that have integer spin: 1) Photon; 2) Gluon; 3) Muon; 4) Higgs Boson

ANSWER: 1 2 4

TOSS-UP

17) Chemistry – *Short Answer* Identify all of the following 3 choices that are true regarding microstates of statistical entropy: 1) The microstates of a perfect crystal at 0 Kelvin has entropy 0; 2) The microstates of a system can be less than 0; 3) The number of microstates is square root proportional to the number of molecules;

ANSWER: 1 ONLY
Written by APLegends1#3363/Atkins

BONUS

17) Chemistry – *Multiple Choice* Which of the following is INCORRECT regarding Grignard reagents?

W) Grignard Reagents can allow for the conversion of acid chlorides into ketones
X) Grignard Reagents can be reacted with carbon dioxide to produce a carboxylic acid
Y) Grignard Reagents can be used for the alkylation of aldehydes
Z) Grignard Reagents are commonly used in ethereal solvents

ANSWER: W) Grignard Reagents can allow for the conversion of acid chlorides into ketones
Written by APLegends1#3363/Org

TOSS-UP

18) Energy – *Multiple Choice* Argonne National Laboratory researchers are inquiring into ways to enrich the diets of American citizens. They find that many citizens are deficient in vitamin B12, which is used in DNA and myelin sheath synthesis. Which of the following transition metals serves as the coordination center of vitamin B12?

W) Cobalt
X) Iron
Y) Chromium
Z) Copper

ANSWER: W) Cobalt

BONUS

18) Energy – *Short Answer* Pacific Northwest National Laboratory's cell biology researchers are studying the primary effectors of cell processes. What term describes the protease enzymes that play critical roles during apoptosis?

ANSWER: Caspases

TOSS-UP

19) Biology – *Multiple Choice* Which of the following correctly matches the hormone and the cell it is primarily secreted from?

W) Alpha and histamine secretion
X) Parietal and Intrinsic Factor
Y) D and pepsinogen
Z) Chief and Somatostatin

ANSWER: X) Parietal and Intrinsic Factor

BONUS

19) Biology – *Short Answer* Identify all of the following 3 choices which correctly matches the nitrogenous base to its product after deamination. 1) Thymine to 5-Methylcytosine; 2) Cytosine to Uracil; 3) Guanine to Xanthine.

ANSWER: 2 AND 3

TOSS-UP

20) Earth and Space – *Short Answer* What name is given to the compact radio source at the center of the Milky Way, corresponding to a supermassive black hole?

ANSWER: SAGITTARIUS A* ["A-star] (DO NOT ACCEPT: SAGITTARIUS A) [2, SPACE] Eric

BONUS

20) Earth and Space – *Multiple Choice* Which of the following is closest to the age of Saturn's rings?

W) 100 million years
X) 500 million years
Y) 1 billion years
Z) 4 billion years

ANSWER: W) 100 MILLION YEARS [2, SPACE] Eric

TOSS-UP

21) Math – *Short Answer* A set S has 10 distinct elements. How many subsets of S have an odd number of elements?

ANSWER: 512 [Combinatorics] <spencerd>

BONUS

21) Math – *Short Answer* John rolls a standard 6-sided dice 10 times. In how many ways can he roll 1 one, 2 two's, 3 three's, and 4 four's?

ANSWER: 12600 <Tony>

TOSS-UP

22) Physics – *Short Answer* A satellite performs a maneuver while traveling in a circular orbit, firing its thrusters such that it barely manages to escape its orbit. By what factor does its speed change during the maneuver?

ANSWER: √2 [Gravitation, 3]
ThisIsDenry#0446

BONUS

22) Physics – *Short Answer* A thin hoop with mass 5 kilograms and radius 2 meters is rolling counterclockwise to the right. What is the speed of the hoop's center of mass after a long time if it starts with a center of mass velocity of 5 meters per second and an angular velocity about its center of mass of 3 radians per second?

ANSWER: 1 [Rotat. Dynamics, 4]
ThisIsDenry#0446

TOSS-UP

23) Chemistry – *Short Answer* Identify all of the following 3 choices that are true regarding the Born Oppenheimer approximation.

1) It neglects the energy derived from nuclear motion
2) It can be used to solve The Schrodinger Equation for H_2^+
3) It cannot be corrected by including vibronic coupling

ANSWER: 1 AND 2
Written by APLegends1#3363/Mcquarrie

BONUS

23) Chemistry – *Multiple Choice* Which of the following should be avoided for alkylation by a lithium enolate?

W) Carboxylic Acids
X) Esters
Y) Aldehydes
Z) Ketones

ANSWER: W) Carboxylic Acids
Written by APLegends1#3363/Org

Commented [2]: is this pronounced H two plus

Commented [3]: yuh