2019 LACES/Venice Science Bowl Scrimmage

Round 1
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TOSS-UP

1) Chemistry - Short Answer - What is the expected bond order of the bridging three-center B-H-B bonds in diborane?

ANSWER: 0.5

BONUS

1) Chemistry - Multiple Choice - Which of the following would be the expected spontaneity of the dihydroxylation of ethylene into ethylene glycol?

W) Spontaneous at all temperatures
X) Spontaneous at low temperatures
Y) Spontaneous at high temperatures
Z) Nonspontaneous at all temperatures

ANSWER: Y) Spontaneous at high temperatures

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TOSS-UP

2) Biology - *Short Answer* - Peptide Tyrosine Tyrosine, commonly known as PYY hormone, acts primarily against which hormone in the human body?

ANSWER: Ghrelin

BONUS
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2) Biology - *Short Answer* - Which section of the small intestine is known for being one of the parts of the human body that secrete the most PYY hormone?

ANSWER: Ileum

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TOSS-UP

3) Earth Science – *Multiple Choice* - Which of the following best describes the main mechanism of formation for tropospheric ozone?

W) H2O splits into H2 and O by ionosphere-to-ground electrolysis, then O and O2 recombine into ozone
X) NO2 splits into NO and O by high energy radiation, then O and O2 recombines into ozone
Y) O2 molecules combine by high energy radiation, releasing ozone and O
Z) O2 splits into two O radicals by high energy radiation, then the O radicals combine with O2 molecules into ozone

ANSWER: X) NO2 splits into NO and O by high energy radiation, then O and O2 recombines into ozone

BONUS

3) Earth Science – *Multiple Choice* - The urban heat island effect is strongest during which of the following conditions?

W) Night, low pressure and relatively strong converging winds
X) Night, high pressure and light winds
Y) Day, low pressure and relatively strong converging winds
Z) Day, high pressure and light winds

ANSWER: X) Night, high pressure and light winds

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TOSS-UP

4) Math - *Short Answer* - Evaluate the derivative with respect to x of $2sin(x) + x^2$.

ANSWER: $2x + 2cos(x)$

BONUS

4) Math - *Short Answer* - Find $\int_0^{\pi/10} cos^5(10x)sin(10x)\,dx$. (Read as: the definite integral from 0 to pi over 10 of the function cosine to the fifth power of ten x *~pause~* times sine of ten x dx)

ANSWER: 0

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TOSS-UP

5) Physics - *Multiple Choice* - Which of the following best describes the process of muon-catalyzed fusion?

W) High energy muons strike hydrogen gas, which is enough energy to break the Coulomb barrier between different molecules, leading to fusion of the hydrogen
X) A stream of muons strikes solid hydrogen, replacing the electrons within the frozen hydrogen, which significantly reduces the electromagnetic repulsion and leads to fusion of the nuclei
Y) A powerful magnetic field cycles high energy muons in a torus, which replaces the electrons within the hydrogen molecules and leads to fusion of the nuclei
Z) Hot hydrogen plasma is bombarded with muons, which drives out the electrons by repulsion, leading to fusion of the nuclei

ANSWER: X) A stream of muons strikes solid hydrogen, replacing the electrons within the frozen hydrogen, which significantly reduces the electromagnetic repulsion and leads to fusion of the nuclei

BONUS

5) Physics - *Short Answer* - A binary star system has two stars of 4 solar masses and 6 solar masses. If the distance between the stars is 4 AU, then to two significant figures, find the period of the stars, in years.

ANSWER: 2.5 years
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TOSS-UP

6) Biology - *Short Answer* - Which of the following is a characteristic seen in the alimentary canal but not the gastrovascular cavity?

W) Digestion
X) One opening
Y) Stepwise digestion
Z) Radial symmetry

ANSWER: Y) Stepwise digestion

BONUS

6) Biology - *Short Answer* - Gingivitis, a non-destructive disease that causes inflammation of the gums, is caused mainly by what type of bacterial consortium?

ANSWER: Biofilm (ACCEPT: Plaque)

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TOSS-UP

7) Chemistry- *Short Answer* - What phenomenon occurs when electrons in a bonding sigma orbital delocalize into adjacent antibonding sigma or pi orbitals, resulting in a shortening of the sigma bond length?

ANSWER: Hyperconjugation

BONUS

7) Chemistry - *Short Answer* - Give the expected magnetism of F_2^-, F_2^+, and F_2^{2+} respectively.

ANSWER: F_2^- is paramagnetic, F_2^+ is paramagnetic, F_2^{2+} is paramagnetic

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TOSS-UP

8) Earth Science - *Multiple Choice* - The minerals ejected by most undersea hydrothermal vents are mostly:

W) phyllosilicates
X) carbonates
Y) inosilicates
Z) sulfides

ANSWER: Z

BONUS

8) Earth Science - *Multiple Choice* - Pillow basalts of the Crescent Formation in western Washington have been metamorphosed by deep-sea hydrothermal activity, then later uplifted onto land. Which of the following metamorphic facies would most likely be encountered in this low grade metabasalt?

W) Zeolite to low-greenschist
X) Amphibolite
Y) Hornfels
Z) Eclogite (ek-lo-jite)

ANSWER: W

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TOSS-UP

9) Math - *Short Answer* - Give all complex solutions, in exponential form, to $x^3 = 1$.

ANSWER: $1, e^{i2\pi/3}$, and $e^{i4\pi/3}$

BONUS

9) Math - *Short Answer* - What is the probability of hitting a bull's eye on a dartboard that is made of concentric circles of radius 1 cm, 3 cm, 5 cm, and 9 cm?

ANSWER: 1/81

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TOSS-UP

10) Physics - *Short Answer* - A series circuit with 3 capacitors of 3 microfarads has a voltage of 5 volts applied across it. Giving your answer in microcoulombs, what is the charge on each capacitor?

ANSWER: 5 microcoulombs

BONUS

10) Physics - *Short Answer* - What is the force exerted on a 2 Coulomb charge moving at 5 m/s north through a 3 Tesla magnetic field that points up? Give both the magnitude and direction.

ANSWER: 30 N towards the East

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TOSS-UP

11) Chemistry - *Short Answer* - What is the oxidation number of arsenic in roselite, a mineral with chemical formula $Ca_2(AsO4)_2 \bullet H_2O$ (Read as: Ca two As O four *~pause~* two dot H two O)?

ANSWER: +6

BONUS

11) Chemistry - *Short Answer* - Which of the following statements is true about substitution reactions? 1) S_N1 reactions proceed with a stereochemical inversion; 2) Nucleophilic attack and

the loss of a leaving group occurs in one step in S_N2 reactions; 3) S_N2 reactions with secondary substrates proceed faster than S_N2 reactions with primary substrates

ANSWER: 2 only

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TOSS-UP

12) Biology - *Short Answer* - What protein acts in the opposite direction of dynein on microtubules in neurons?

ANSWER: Kinesin

BONUS

12) Biology - *Short Answer* - How many legs does a single peptide of dynein have?

ANSWER: 2

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TOSS-UP

13) Earth Science - *Multiple Choice* - Which of the following is NOT characteristic of tidal tails?

W) They form from the tidal interaction of two galaxies
X) Galaxies can eject up to half of its mass into a tidal tail
Y) Tidal tails can be used to calculate the geometry of the dark matter halo around an interacting galaxy
Z) Tidal tails cause intense star formation, accounting for up to 95% of the star formation in an interacting galaxy

ANSWER: Z) Tidal tails cause intense star formation, accounting for up to 95% of the star formation in an interacting galaxy

BONUS

13) Earth Science - *Short Answer* - The wavelength of a shallow water wave is 10.5 meters. To two significant figures, estimate the height that the wave must reach to form whitecaps.

ANSWER: 1.5 meters

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TOSS-UP

14) Math - *Short Answer* - Find all real $x \in [0,2\pi]$ such that $csc(x) = 2$.

ANSWER: $5\pi/6$ and $\pi/6$

BONUS

14) Math - *Short Answer* - David selects a random number between 0 and 1. Dan also selects a random number between 0 and 1. What is the probability that their numbers differ by less than 0.25?

ANSWER: 7/16

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TOSS-UP

15) Physics - *Multiple Choice* Which of the following laws is most applicable when finding the force exerted on a moving charge through a magnetic field?

W) Faraday's Law
X) Lorentz Force law
Y) Ampere's Law
Z) Biot-Savart Law

ANSWER: X) Lorentz Force Law

BONUS

15) Physics- *Short Answer* - A 5.0 kg mass and a 3.0 kg mass are attached to opposite ends of a string which is put on a massless pulley. What is the acceleration of the 3.0 kg mass, in meters per second squared?

ANSWER: $2.5\frac{m}{s^2}$

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TOSS-UP

16) Chemistry- *Short Answer* - Rank the following liquids in increasing vapor pressure at 25 degrees Celsius: pentane, water, ethanol.

ANSWER: 2, 3, 1 (water, ethanol, pentane)

BONUS

16) Chemistry - *Short Answer* – Which of the following is true about the second order reaction $2A \rightarrow B$ (Read as: two A yields B)? 1) the graph of $\frac{1}{[A]}$(Read as: one over the concentration of A) versus time yields a straight line; 2) the half life of A is proportional to $ln(A)$; 3) the rate of disappearance of A increases over time.

ANSWER: 1 only

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TOSS-UP

17) Biology - *Short Answer* - What is the name for a taxon that branches off from the rest of a monophyletic group early in the phylogenetic tree?

ANSWER: Basal taxon

BONUS

17) Biology - *Short Answer* - Which phylum is the basal taxon of Animalia?

ANSWER: Porifera (DO NOT ACCEPT: Sponges)

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TOSS-UP

18) Earth Science - *Short Answer* - What is the name of the group of asteroids that occupy the fourth and fifth Lagrange points of Jupiter?

ANSWER: Jupiter Trojans (Accept: Trojans)

BONUS

18) Earth Science - *Short Answer* - What is the type of precession that occurs as the moon's semimajor axis rotates, causing the perigee and apogee to shift?

ANSWER: Apsidal precession

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TOSS-UP

19) Math - *Short Answer* - Evaluate the limit of $\frac{sin\ (x)}{x}$ as x approaches 0.

ANSWER: 1

BONUS

19) Math - *Short Answer* - Given the function $f(x) = \frac{x^3-\sqrt{x}}{x^2+1}$, find $f'(1)$.

ANSWER: 5/4

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TOSS-UP

20) Physics - *Multiple Choice* - A 4 kg mass is attached to a spring with spring constant 16 N/m and is displaced 5 m from the equilibrium position. It is released and allowed to oscillate. What is its velocity 3 m from its equilibrium position?

W) 4 m/s
X) 5 m/s
Y) 6 m/s
Z) 8 m/s

ANSWER: Z) 8 m/s

BONUS

20) Physics - *Short Answer* - A 5 kg, 6 m long solid rod with uniform mass density is pivoted 2 m from its center. To the nearest whole number, what is its angular frequency of small oscillations?

ANSWER: 2 s^{-1}

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TOSS-UP

21) Chemistry- *Short Answer* - The Suzuki reaction, commonly used to synthesize styrenes and substituted biphenyls, is catalyzed by what element?

ANSWER: Palladium (Accept Pd)

BONUS

21) Chemistry - *Short Answer* - Which of the following is true about crystal field theory? 1) ligands are represented by negative point charges; 2) in octahedral d^1 complexes, the d_{z2} and d_{x2-y2} orbitals are higher energy than the d_{xy}, d_{zx}, and d_{yz} orbitals; 3) ligands that cause a large splitting energy are associated with high-spin complexes.
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ANSWER: 1 and 2

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TOSS-UP

22) Biology - *Multiple Choice* - Which of the following most accurately states the chemical structure of calcitonin?

W) Cholesterol-derived hormone
X) Tryptophan-derived hormone
Y) Tyrosine-derived hormone
Z) Peptide hormone

ANSWER: Z) Peptide hormone

BONUS

22) Biology - *Short Answer* - Which cranial nerve transmits sound and balance information from the inner ear to the brain?

ANSWER: Vestibulocochlear nerve (Accept: Cranial nerve 8, auditory vestibular nerve)

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TOSS-UP

23) Earth Science - *Short Answer* - What type of atmospheric instability occurs when there is significant wind shear, causing local turbulence in a series of wave-like eddies?

ANSWER: Kelvin-Helmholtz instabilities (accept: KHI, Fluctus clouds are fine, I guess)

BONUS

23) Earth Science - *Multiple Choice*- Which of the following is NOT true about tectonics?

W) Rising magma from flux melting associated with subduction can cause divergence parallel to the subducting plate
X) Plates are not driven by traction imposed by convection currents, but are part of the convective motion themselves
Y) Steep angle subduction is associated with volcanic gaps
Z) An accretionary prism is mostly composed of compressed oceanic sediments

ANSWER: Y) Steep angle subduction is associated with volcanic gaps

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TOSS-UP

24) Math - *Short Answer* - Evaluate the limit as $x$approaches 1 of $\frac{x^{1/3}-1}{x^{1/4}-1}$(Read as: the quantity x to the one third power minus one over the quantity x to the one fourth power minus one).

ANSWER: 4/3

BONUS

24) Math - *Short Answer* - A particle moving along the x axis is described by the velocity function $v(t) = 6t^2 + 4t + 2$, where v(t) is the velocity in meters per second. Assuming the particle starts at a position of 4 meters to the right of the origin, what is the displacement of the particle with respect to the origin, in meters, from $t = 1$second to $t = 3$seconds?

ANSWER: 72 meters

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TOSS-UP

25) Physics- *Multiple Choice* - Planets A and B are in circular orbits around a common star. If Planet A's orbital radius is four times as large as Planet B, what is the ratio of Planet A's orbital period to Planet B's orbital period?

W) 2
X) $\sqrt[3]{4}$
Y) $4^{3/2}$
Z) $4^{2/3}$

ANSWER: Y) $4^{3/2}$

BONUS

25) Physics - *Short Answer* - What is the dimensionless number that denotes the degree of magnetization of a given material in response to an applied magnetic field?

ANSWER: Magnetic susceptibility (Accept: Chi)