Winter Science Bowl Tournament 2022-2023

Finals 1

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TOSS-UP

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

ANSWER: 2 ONLY
Written by: APLegends1#3363

BONUS

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

1) Opposite is the most common phyllotaxy
2) Sunflowers exemplify a distichous phyllotaxy
3) Grasses exemplifies a whorled phyllotaxy

ANSWER: NONE
Written by: APLegends1#3363

TOSS-UP

2) Earth and Space – *Short Answer* Identify all of the following 3 statements that are true of polymetallic nodules: 1) They are most abundant in abyssal plains; 2) They grow extremely slowly; 3) They are mostly composed of manganese oxide by mass.

ANSWER: ALL [4, OCE] Tony

BONUS

2) Earth and Space – *Short Answer* Order the following 3 bodies of water by decreasing average sea-surface salinity: 1) Pacific Ocean; 2) Atlantic Ocean; 3) Mediterranean Sea.

ANSWER: 3 2 1 [3, OCE] Tony

TOSSUP

3) Math – *Short Answer* Evaluate the following:

$$\sum_{x=1}^{\infty} \frac{(-1)^x}{x!}$$

Answer: $\frac{1}{e} - 1$

BONUS

3) Math – *Multiple Choice* x and y are chosen independently and uniformly at random from the closed interval [0,2]. What is the probability that $x \cdot y < 1$?

W) $\frac{2 \cdot \ln(2)+1}{4}$
X) $\frac{2 \cdot \ln(2)-1}{4}$
Y) $\frac{\ln(2)+1}{2}$
Z) $\frac{\ln(2)-1}{2}$

Answer: W

TOSS-UP

4) Physics - *Short Answer* What fictitious force is a consequence of a reference frame with a changing angular velocity?

ANSWER: Azimuthal force OR Euler force
dannyridel#2256

BONUS

4) Physics - *Multiple Choice* The processional frequency of a Foucault pendulum located at a certain polar angle θ is directly related to which of the following trigonometric functions of θ?
W) sine
X) cosine
Y) hyperbolic tangent
Z) tangent

ANSWER: X) cosine
dannyridel#2256

TOSS-UP

5) Chemistry - *Short Answer* Identify all of the following three choices that are TRUE regarding interactions between strictly alcohols and a hydrogen halide.

1) A primary alcohol and a hydrogen halide undergo SN1
2) A secondary alcohol and a hydrogen halide undergo SN2
3) A tertiary alcohol and a hydrogen halide undergo E1

ANSWER: 2 only

BONUS

5) Chemistry – *Short Answer* Identify the following statements which are true regarding nucleation: 1) Nucleation is usually unpredictable even in identical systems; 2) Heterogeneous nucleation is much more common than homogeneous nucleation; 3) Nucleation can produce solids, liquids, and gasses

ANSWER: All

TOSS-UP

6) Energy – *Short Answer* What organic compound, which recycles ADP to ATP in vertebrates, is often used as a booster of athletic performance and is known to increase retention of water in myocytes?

ANSWER: Creatine

BONUS

6) Energy – *Short Answer* Which of the following is true of piezoelectricity?
1) It is reversible
2) It can be observed in ceramics
3) It cannot be observed in crystals

ANSWER: 1 and 2

TOSS-UP

7) Biology - *Short Answer* Identify all of the following 3 pairs which correctly match the hormone and the gland which it is released from: 1) Thyroid releasing hormone and Anterior Pituitary; 2) Thyroid Stimulating Hormone and Hypothalamus; 3) Thyroxine and Anterior Pituitary.

ANSWER: NONE
Written by: APLegends1#3363

BONUS

7) Biology - *Short Answer* Identify all of the following 3 phylums which represent bryophytes. 1) Liverworts; 2) Hornworts; 3) Mosses.

ANSWER: ALL
Written by: APLegends1#3363

TOSS-UP

8) Earth and Space – *Short Answer* What type of galaxy, found at the center of the Hubble tuning fork diagram, is shaped like a solid disk and is intermediate between spirals and ellipticals?

ANSWER: LENTICULAR or S0 [4, SPACE] June

BONUS

8) Earth and Space – *Short Answer* Galaxy A has a stellar velocity dispersion of 50 km/s in its galactic bulge, and has a central black hole with a mass of 10 million solar masses. If Galaxy B has a velocity dispersion of 100 km/s in its bulge, what is the approximate mass of the black hole at Galaxy B's center?

ANSWER: 320 MILLION SOLAR MASSES (By the M-sigma relation, black hole mass ~ velocity dispersion ^ 5, so Mb/Ma = (100/50)^5 and Mb = 10 billion x 2^5 = 320 billion.) [4, SPACE] June

TOSSUP

9) Math – *Short Answer* Define a sequence with the following recurrence relation:
$x_{n+1} = (x_1)^{(x_n)}$ for $n \geq 1$
For example, $x_2 = {x_1}^{x_1}$ and $x_3 = {x_1}^{x_1^{x_1}}$
If $x_1 = \sqrt{2}$, then evaluate $lim_{n\to\infty}\ (x_n)$
Answer: 2

BONUS

9) Math – *Short Answer* Evaluate the following expression:
$lim_{x\to\infty} \sum_{n=x}^{2x} \frac{1}{n}$
Answer: $ln(2)$

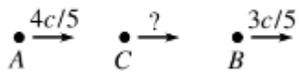
TOSS-UP

10) Physics - *Short Answer* The tidal force on an object is proportional to what power of the distance from the source?
ANSWER: -3
dannyridel#2256

VISUAL BONUS

10) Physics - *Short Answer* Two spaceships A and B travel at 4c/5 and 3c/5 with respect to a stationary frame, as shown in the figure. How fast should spaceship C travel so that its captain sees spaceships A and B approach her at the same speed?

ANSWER: 5c/7
dannyridel#2256 (yes, it's only visual because I think they need 30 seconds)



TOSS-UP

11) Chemistry - *Short Answer* Identify all of the following components that could be present in a SN2 reaction, regarding the substrate and reagent properties, respectively: 1) Primary substrate, strong base, weak nucleophile; 2) Tertiary substrate, weak base, strong nucleophile; 3) Tertiary substrate, strong base, strong nucleophile

ANSWER: NONE

BONUS

11) Chemistry – *Short Answer* Identify all of the following 3 statements which are true of enantiomers: 1) Enantiomers exhibit identical optical properties; 2) Enantiomers are structural isomers; 3) Enantiomers exhibit identical physical properties.
ANSWER: 3 ONLY

TOSS-UP

12) Energy – *Short Answer* NASA astronomers observe that small, bright nebulae form when narrow jets of partially ionized gas ejected by newly born stars interact with clouds of gas and dust. What are these nebulae called?

ANSWER: Herbig-Haro objects

BONUS

12) Energy – *Short Answer* What is the tool used to create light with perfectly parallel waves that will not spread during propagation?

ANSWER: Collimator

TOSS-UP

13) Biology - *Short Answer* What group of conducting-system fibers located within the interventricular septum propagates action potentials from the AV node?

ANSWER: BUNDLE OF HIS

BONUS

13) Biology – *Multiple Choice* Which of the following is true about skeletal muscles?

W) Units are connected by gap junctions

X) They contain dense bodies to help with contraction

Y) Units consistently undergo cell division

Z) When muscles contract, the H zone shrinks

ANSWER: Z) WHEN MUSCLES CONTRACT, THE H ZONE SHRINKS

TOSS-UP

14) Earth and Space – *Multiple Choice* Which of the following rocks would you NOT expect to find in the lunar highlands?

W) Anorthosite
X) Breccia
Y) Basalt
Z) Norite

ANSWER: Y) BASALT [3, SPACE] June

BONUS

14) Earth and Space – *Short Answer* Identify all of the following that are plausible hypotheses for how supermassive black holes could have formed: 1) accretion of nearby matter over billions of years; 2) rapid infall of matter inside a massive quasi-star; 3) mergers between intermediate-mass precursors; 4) direct collapse of a low-metallicity gas cloud.

ANSWER: 1 2 3 (ACCEPT: ALL BUT 4) [4, THRY] June

TOSS-UP

15) Math – *Short Answer* Find the only positive composite integer n that does not divide $(n-1)!$ [n-1 factorial]?
Answer: 4

BONUS

15) Math – *Short Answer* What is the arc length of the function $y = \frac{2}{3}x^{\frac{3}{2}}$ from x=-1 to x=3?

ANSWER: $\frac{16}{3}$ [Calc II] <spencerd>

TOSS-UP

16) Physics - *Short Answer* Which of the following 4 systems are examples of chaotic motion?

1) Inverted pendulum
2) Kapitza's pendulum
3) Double pendulum
4) Inverted double pendulum

ANSWER: 3 and 4 only (much easier than it looks, 50/50 for 2 ig)
dannyridel#2256

BONUS

16) Physics - *Short Answer* What mathematical method is often used to solve initial value problems with differential equations that are not numerically solvable, a notable application being in the double pendulum?

ANSWER: Runge-Kutta method
dannyridel#2256

TOSS-UP

17) Chemistry– *Multiple Choice* Which of the following wavelengths, in nanometers, is closest to the longest possible wavelength of electromagnetic radiation sufficient to eject photoelectrons from silver given that the work function is 4.7eV?

W) 100

X) 250

Y) 350

Z) 450

ANSWER: X) 250

BONUS

17) Chemistry – *Short Answer* What term describes donation of electron density into p-orbitals from neighboring sigma bonds that stabilizes carbocations?

ANSWER: HYPERCONJUGATION

TOSS-UP

18) Energy - *Short Answer* What term describes the equilibrium that makes the Earth's lithosphere seem as if it floats upon the asthenosphere, which controls the elevation of regions of the crust depending on the density of the underlying rock?

ANSWER: Isostasy; isostatic equilibrium

BONUS

18) Energy – *Short Answer* What term describes the natural parallel electric current flowing on or beneath the surface of the Earth, which is used to map subsurface geophysical structures?

ANSWER: Telluric current; Earth current

TOSS-UP

19) Biology - *Short Answer* What condition involves an enlarged thyroid gland due to elevated concentrations of thyroid stimulating hormones?

ANSWER: GOITER

BONUS

19) Biology - *Multiple Choice* Which of the following IS NOT a factor which directly impacts resistance inside of a blood vessel according to Poiseuille's Law?

W) Fluid viscosity

X) Length of the vessel

Y) Fluid turbulence

Z) Radius of the vessel

ANSWER: Y) Fluid turbulence

TOSS-UP

20) Earth and Space – *Short Answer* Researchers hypothesize that some parts of the Canadian Cordillera, that seem completely unrelated to the neighboring geography, have actually been accreted onto the North American plate. What is the general name for these crustal fragments that are accreted onto the crust of another plate as the plate it's on gets subducted?

ANSWER: TERRANE [3, GEO] Tony

BONUS

20) Earth and Space – *Short Answer* Which of the following minerals is least likely to be found in placer deposits?

W) Gypsum
X) Gold
Y) Platinum
Z) Wolframite

ANSWER: W) GYPSUM [3, GEO] Tony

TOSSUP

21) Math – *Short Answer* Define v2(n) as the largest integer k such that 2k | n [2 to the k divides n]. If v2(a)=10 and v2(b)=20, what is v2(a+b)?

Answer: 10

BONUS

21) Math – *Short Answer* Find dy/dx given the parametrically defined curve x=2cos(2t) and y=-3sin(2t) in terms of t.

ANSWER: $\frac{3 \cdot cot(2t)}{2}$ (accept cos/sin in replacement of cot) [4, CALC II] <Rak>

TOSS-UP

22) Physics - *Short Answer* The potential for a mass hanging from a spring is V(y) = $ky^2 + mgy$, where y = 0 corresponds to the initial equilibrium position of the spring when nothing is hanging on it. Find the angular frequency of small oscillations around the equilibrium point.

ANSWER: sqrt(k/m)
dannyridel#2256 (once again easier than it looks)

BONUS

22) Physics - *Short Answer* A small mass rests on top of a fixed, frictionless sphere. The mass is given a small push and slides downward. Find the point it loses contact with the sphere, and express your answer in an inverse trigonometric ratio.

ANSWER: inverse cosine of ⅔
dannyridel#2256

TOSS-UP

23) Chemistry - *Multiple Choice* Which of the following types of liquids most generally undergo particle deposition?

W) Solutions

X) Crystalloids

Y) Colloids

Z) Suspensions

ANSWER: Y) Colloids

BONUS

23) Chemistry - *Short Answer* What group of resonance stabilized intermediate complexes, including dihydrogen complexes, is a result of nucleophilic attack on the aromatic ring ?

ANSWER: Sigma Complex (ACCEPT: Arenium Ion)