Winter Science Bowl Tournament 2022-2023

Playoff Round 4

a5a7#2184, APLegends1#3363, cymbidium#2318‡, dan.k.memes#5912‡, dannyridel#2256, EVTrainer#5388, juneboon#0962, ℜara#3565, P2ep0#1900, spencerd#4926, ThisIsDenry#0446, Vc05#6115, Vish#8148

Past and Present Sponsors



TOSS-UP

1) Biology – *Short Answer* Identify all of the following 4 immunoglobulins that ARE NOT monomers.

1) IgG
2) IgM
3) IgA
4) IgE

ANSWER: 2 AND 3

BONUS

1) Biology – *Multiple Choice* Which of the following is NOT true regarding Cnidaria?

W) Cnidarians contain only one opening to their central cavity, functioning as a mouth and anus
X) Cnidaria, unlike other eumetazoans, do not contain a nerve net
Y) The central cavity of Cnidarians acts as a hydrostatic skeleton
Z) Jellyfish are an example of a medusa while Hydras are an example of a polyp

ANSWER: X) Cnidaria, unlike other eumetazoans, do not contain a nerve net

TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following best describes the passing star hypothesis?

W) A passing star created shockwaves, triggering the formation of the Sun

X) A passing star pulled matter out of the Sun to create the planets

Y) Matter from a passing star created the Jovian planets

Z) A passing star captured many solar system planetesimals

ANSWER: X) A PASSING STAR PULLED MATTER OUT OF THE SUN TO CREATE THE PLANETS [3, THRY] Tony

BONUS

2) Earth and Space – *Short Answer* Identify all of the following 3 statements that are true regarding belt-zone atmospheric circulation: 1) belts and zones move antiparallel to each other; 2) the belt-zone system is comprised of regions of rising and falling gases or liquids; 3) belt-zone circulation is present on Mars;

ANSWER: 1 AND 2 [3, SPACE] Tony

TOSS-UP

3) Math – *Multiple Choice* Which of the following most accurately defines prime knots?

W) Prime knots are knots that are unable to be written as the knot sum of two non-trivial knots

X) Prime knots are knots that are unable to be written as the knot product of two non-trivial knots

Y) Prime knots are knots that have a crossing number that is prime

Z) Prime knots are knots that have the same crossing number as their knot complement

ANSWER: W [Topology] <spencerd>

BONUS

3) Math – *Short Answer* Find the equation of the line tangent to the curve $y = sin(cos(x))$ at the point $(\frac{\pi}{2}, 0)$.

ANSWER: $y = -x + \frac{\pi}{2}$ [Calc I] <spencerd>

TOSS-UP

4) Physics – *Multiple Choice* Which of the following most accurately describes red light?

W) It has a wavelength of approximately 500 nm
X) It has a frequency of approximately 420 THz
Y) It has the highest energy out of all colours of visible light
Z) It can penetrate thin sheets of metal

ANSWER: X) It has a frequency of approximately 420 THz
dannyridel#2256, waves, 2

BONUS

4) Physics - *Short Answer* In which of the following devices is light refracted? 1) Cameras 2) Projectors 3) Telescopes
ANSWER: All
dannyridel#2256, waves, 2

TOSS-UP

5) Chemistry - *Multiple Choice* Osmium tetroxide is the standard oxidizing reagent for producing which of the following compounds from alkenes?

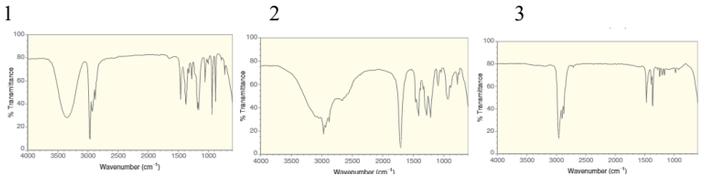
W) Ester
X) Diol
Y) Aldehyde
Z) Ketone

ANSWER: X) Diol

VISUAL BONUS

5) Chemistry - *Short Answer* Identify the following IR spectra which is consistent of a structure of carboxylic acid.

1 2 3



ANSWER:2 ONLY

TOSS-UP

6) Energy – *Short Answer* While researching sonar, Argonne National Lab researchers find that bubbles in a liquid emit light when excited to implode by sound waves. What effect do they observe?

ANSWER: Sonoluminescence

BONUS

6) Energy – *Short Answer* NASA's Gravity Probe B observes that Earth's mass produces a curvature of space-time that causes the circumference of an orbiting object to be smaller than it would be if space-time was flat. What effect does the probe observe?

ANSWER: Geodetic effect; de Sitter effect

TOSS-UP

7) Biology - Short Answer Identify all of the following 4 cranial nerves that contain both afferent and efferent fibers.

1) Abducens
2) Vagus
3) Vestibulocochlear
4) Hypoglossal

ANSWER: 1 AND 2

VISUAL BONUS



7) Biology - Short Answer What lymphoid structure is depicted above, found in the ileum of the small intestine?

ANSWER: Peyer's Patch
Written by: APLegends1#3363

TOSS-UP

8) Earth and Space – *Multiple Choice* Which of the following pairs of minerals are polymorphs of each other?

W) calcite and aragonite

X) dolomite and malachite

Y) kaolinite and olivine

Z) biotite and muscovite

ANSWER: W) CALCITE AND ARAGONITE [2, GEO] Tony

BONUS

8) Earth and Space – *Multiple Choice* Which of the following most accurately describes horst-graben topography?

W) Horsts bounded by two normal faults

X) Horsts bounded by two reverse faults

Y) Horsts bounded by two strike-slip faults

Z) Horsts bounded by one normal and one reverse fault

ANSWER: W) HORSTS BOUNDED BY TWO NORMAL FAULTS [2, GEO] Tony\

TOSS-UP

9) Math – *Short Answer* Evaluate the following: $\int_{-5}^{5} \sqrt{25 - x^2}\, dx$ (the integral from -5 to 5 of the expression square root of the quantity 25 minus x squared *pause* dx)

ANSWER: 12.5π *or* $\frac{25}{2}\pi$

BONUS

9) Math – *Short Answer* How many times can $(20^9 - 11^9)$ be evenly divided by 3?

ANSWER: 4 [Number Theory] <spencerd>

TOSS-UP

10) Physics - *Multiple Choice* The weak nuclear force is around how many times stronger than the strong nuclear force?
W) 10^{-1}
X) 10^{-2}
Y) 10^{-3}
Z) 10^{-6}

ANSWER: Z
Vc05#6115

BONUS

10) Physics - *Short Answer* A circular loop of wire in the x-y plane has a diameter of 4 centimeters, a resistivity of 50 nano-ohm meters, and a cross-sectional area of 3 x 10^{-5} m^2. A uniform magnetic field starts at 0 teslas and increases uniformly over 3 seconds until it reaches a value of 2 teslas in the positive z direction. What is the magnitude of the induced current in the wire in amperes as the magnetic field is turning on?

ANSWER: 4

dannyridel#2256

TOSS-UP

11) Chemistry - Multiple Choice Which of the following spectroscopic techniques would be most useful for studying surfaces by using energetic electrons emitted from an excited atom?

W) Raman Spectroscopy
X) Auger Spectroscopy
Y) Mossbauer Spectroscopy
Z) Hadron Spectroscopy

ANSWER: X) Auger Spectroscopy

BONUS

11) Chemistry - Multiple Choice Which of the following is INCORRECT regarding properties of nitrogen gas?

W) It is resistant to simple electron-transfer redox processes
X) It promotes the formation of highly polar transition states
Y) It has a high activation point
Z) Its metal coordination complexes are analogous to CO derivatives

ANSWER: X) It promotes the formation of highly polar transition states

TOSS-UP

12) Energy – *Short Answer* Oak Ridge National Lab researchers often analyze properties such as crystallinity, lattice parameters, and phase transitions. What technique, which measures the intensity of neutrons and scattering angle, do they use?

ANSWER: powder diffraction; X-ray/neutron powder diffraction

Accept x-Ray or neutron diffraction

BONUS

12) Energy – *Short Answer* Ames National Lab chemists separate analytes by their size in organic solvents. What technique, which commonly involves a column of dextran or agarose beads, do they use?

ANSWER: Size-exclusion chromatography; gel permeation chromatography

TOSS-UP

13) Biology - Short Answer Identify all of the following 3 choices that are TRUE regarding halophytes.

1) Their vacuoles contain a greater solute concentration than their environment
2) The presence of calcium ions is thought to be essential for regulating sodium-potassium pumps in their root cells
3) Both Halophytes and Vascular Plants require sodium as an essential element

ANSWER: 1 AND 2

BONUS

13) Biology - *Short Answer* Alice is studying protein-induced membrane curvature. She finds that a variety of membrane proteins which cause membrane curvature contain a shared sequence of amino acids.What is the name of this protein structure, characterized by a conserved sequence of positively charged amino acid residues?

ANSWER: BAR Domains

TOSS-UP

14) Earth and Space – *Short Answer* Identify all of the following that can be generated by a neutron star collision: 1) kilonova; 2) gamma-ray burst; 3) gravitational waves.

ANSWER: ALL [3, SPACE] Eric

BONUS

14) Earth and Space – *Multiple Choice* Which of the following best describes the orbital resonance between the plutinos and Neptune?

W) 1:2

X) 2:5

Y) 2:3

Z) 3:4

ANSWER: Y) 2:3 [3, SPACE] Tony

TOSS-UP

15) Math – *Short Answer* A positive integer y less than or equal to 10 satisfies the following property: There exist an infinite amount of positive integers x such that $10x + y$ is prime. How many possible values of y are there?

ANSWER: 4

BONUS

15) Math – *Short Answer* Identify all of the following 3 infinite summations which diverge.

1) $\Sigma_{x=1}^{\infty} \blacksquare \frac{1}{x}$

2) $\Sigma_{x=1}^{\infty} \blacksquare \frac{x^2}{x^3+x^2}$

3) $\Sigma_{x=1}^{\infty} \blacksquare sin(x)$

ANSWER: ALL

TOSS-UP

16) Physics – *Short Answer* A moon with mass 5×10^{15} kg is in a circular orbit of radius 2.0×10^{8} m about a planet with mass 5×10^{20} kg. What is the change in total energy of the moon due to the planet in one period?

ANSWER: 0 J [Gravitation, 2]
Vc05#6115

BONUS

16) Physics – *Short Answer* For an ideal gas, the probability density of the gas particles at energy E is g(E). In terms of g(E), what is the new probability density when the energy is doubled?

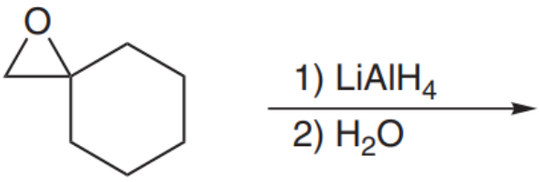
ANSWER: $\sqrt{2}/e^2$ [Kinetic Theory, 5]
ThisIsDenry#0446

TOSS-UP

17) Chemistry - Short Answer Identify the following 3 choices that are true of Zintl Phases containing alkali metals. 1) They are generally paramagnetic 2) They are strong conductors 3) They are malleable

ANSWER: NONE

VISUAL BONUS



17) Chemistry - Multiple Choice Which of the following is incorrect regarding the ring opening reaction of this epoxide?

W) The product of this reaction is chiral
X) The starting reactant is asymmetrical
Y) There cannot be an acid present in this reaction
Z) The nucleophile of this reaction is a hydride

ANSWER: W) The product of this reaction is chiral

TOSS-UP

18) Energy – *Short Answer* Ames National Lab meteorologists observe electrical currents flowing in the Earth's ionosphere. What currents, which are caused by the movement of plasma perpendicular to a magnetic field, do they observe?

ANSWER: Birkeland Currents; field-aligned currents

BONUS

18) Energy – *Short Answer* Meteorologists at Ames National Lab also observe that electromagnetic waves produced from lightning create spectrum peaks of extremely low frequencies. What phenomenon do they observe?

ANSWER: Schumann Resonances

TOSS-UP

19) Biology - *Short Answer* What derivative of vitamin A1 is the light harvesting pigment contained in bacteriorhodopsin?

ANSWER: Retinal (DO NOT ACCEPT: Retinol)
Written by: APLegends1#3363

BONUS

19) Biology - *Multiple Choice* Which of the following is NOT true regarding the production of the thyroid hormones T_3 and T_4 in the thyroid gland?

W) Iodide is co-transported into the follicular cells with sodium
X) Iodide is transported into the follicle lumen by the chlorine/iodide transporter pendrin
Y) Iodide is attached to rings of tryptophan in thyroglobulin in the follicle lumen
Z) Thyroglobulin is synthesized by follicle cells

ANSWER: Y) Iodide is attached to rings of tryptophan in thyroglobulin in the follicle lumen

TOSS-UP

20) Earth and Space – *Short Answer* Identify all of the following three properties that calcite exhibits: 1) UV fluorescence; 2) Perfect cubic cleavage; 3) Strong double refraction.

ANSWER: 1 AND 3 [2, GEO] Tony

BONUS

20) Earth and Space – *Short Answer* Order the following three geologic time periods from earliest to latest: 1) Silurian; 2) Devonian; 3) Cambrian.

ANSWER: 3 2 1 [2, GEO] Tony

TOSS-UP

21) Math – *Short Answer* What is the value of $cosh^2(10e) - sinh^2(10e)$?

ANSWER: 1 [IDK topic] <spencerd>

BONUS

21) Math – *Short Answer* Vivek and Bert are standing in a line with 8 other people in it. If the line randomly changes its order, what is the probability that Vivek and Bert end up standing next to each other in the line?

ANSWER: $\frac{1}{5}$

TOSS-UP

22) Physics – *Short Answer* The coefficient of volume expansion of water is 210 x 10^{-6} K^{-1} at 20 ºC. If the density of water at 20 ºC is 1 g/mL, then to one significant figure and in g/mL, by much does the density of water change when it is heated to 21 ºC?

ANSWER: -0.0002 (DO NOT ACCEPT: 0.002) [Temperature, 3]

ThisIsDenry#0446

Commented [1]: luckily we have this clarification

BONUS

22) Physics – *Short Answer* The difference in length is constant with temperature between a rod of silver, which has a coefficient of linear expansion of 18 x 10^{-6} K^{-1}, and another rod of tungsten, which has a coefficient of linear expansion 4.5 x 10^{-6} K^{-1}. The sum of the length of the two rods is 15 m, what is the length of the silver rod?

ANSWER: 3 [Temperature, 5]

ThisIsDenry#0446

TOSS-UP

23) Chemistry - *Short Answer* The Marsh test uses zinc powder and sulfuric acid to identify what toxic element?

ANSWER: Arsenic

BONUS

23) Chemistry - *Short Answer* Identify all the following 4 choices that are generally true of silanes.

1) They are more active than alkanes
2) Their stability decreases with increasing chain length
3) They are prepared commercially by reduction using aluminum catalysts
4) They are reducing agents in aqueous solution

ANSWER: ALL