SBL FALL ROUND 12

TOSS-UP

1) Chemistry – *Short Answer* What is the hybridization of the central carbon atom in urea?

ANSWER: SP2

BONUS

1) Chemistry – *Short Answer* Rank the following three compounds in terms of increasing pKa: 1) Acetic acid; 2) Ammonium chloride; 3) Chloric acid.

ANSWER: 3, 1, 2

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TOSS-UP

2) Biology – *Short Answer* From what cells in the Islets of Langerhans is insulin released?

ANSWER: BETA CELLS

BONUS

2) Biology – *Short Answer* Identify all of the following three plant hormones that are unique to monocots: 1) Auxins; 2) Gibberellins; 3) Ethylene.

ANSWER: NONE
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TOSS-UP

3) Earth and Space – *Multiple Choice* Which of the following glacial features is strictly erosional?

W) Cirque ***[SIRK]***
X) Lateral moraine
Y) Esker
Z) Ground moraine

ANSWER: W) CIRQUE

BONUS

3) Earth and Space – *Short Answer* Rank the following three planetary bodies in terms of increasing average surface temperature: 1) Venus; 2) Mercury; 3) Mars.

ANSWER: 3, 2, 1

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TOSS-UP

4) Math – *Short Answer* 10 people are standing in a circle. How many ways are there to choose 2 people such that they are not standing next to each other?

ANSWER: 35

BONUS

4) Math – *Short Answer* What is the sum of the x coordinates of the inflection points of the function $y = 3x^4 - 9x^3 + 10x^2 + 2x + 8$?

ANSWER: 3/2
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TOSS-UP

5) Energy – *Multiple Choice* Scientists at Pacific Northwest National Lab are investing alternatives to PGMs, or platinum group metals, for use as inert surface catalysts in electronic materials. Which of the following elements is a PGM?

W) Niobium
X) Palladium
Y) Molybdenum
Z) Technetium

ANSWER: X) PALLADIUM

BONUS

5) Energy – *Multiple Choice* Researchers at Lawrence Berkeley National Lab have been imaging one-dimensional graphene layers for their potential applications as circuitry components. Which of the following types of microscopy were they likely using?

W) Electron microscopy
X) Fluorescence microscopy
Y) Scanning tunneling microscopy
Z) Phase-contrast microscopy

ANSWER: Y) SCANNING TUNNELING MICROSCOPY

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TOSS-UP

6) Physics – *Short Answer* Heisenberg's uncertainty principle can be stated in terms of energy and what other quantity?

ANSWER: TIME

BONUS

6) Physics – *Short Answer* What quantity measures the resulting intensity of an electromagnetic wave passing through a barrier in terms of the incident intensity?

ANSWER: TRANSMISSION COEFFICIENT
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TOSS-UP

7) Earth and Space – *Short Answer* Rank the following four metamorphic rocks in terms of increasing grade: 1) Muscovite schist; 2) Garnet schist; 3) Phyllite; 4) Gneiss ***[nice]***.

ANSWER: 3, 1, 2, 4

BONUS

7) Earth and Space – *Short Answer* What method of distance measurement involves using the redshift of an object's spectrum to determine its distance?

ANSWER: SPECTROSCOPIC PARALLAX (DO NOT ACCEPT: PARALLAX)

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TOSS-UP

8) Biology – *Short Answer* What animal phylum possesses spicules and no true tissues?

ANSWER: PORIFERA

BONUS

8) Biology – *Short Answer* Order the following three flower whorls from innermost to outermost in a perfect flower: 1) Stamens; 2) Sepals; 3) Petals.

ANSWER: 1, 3, 2
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TOSS-UP

9) Energy – *Short Answer* Researchers at Idaho National Lab are studying the vadose zones near wastewater ponds in the Snake River Plain. Movement of water in this zone may be described by what law?

ANSWER: DARCY'S LAW

BONUS

9) Energy – *Multiple Choice* Scientists at Fermilab have been using particle accelerators to better understand early universe conditions. Which of the following statements is NOT true regarding particle accelerators?

W) Larger particle accelerators help study more massive particles
X) Magnetic fields are used to keep particles in a circular orbit
Y) Synchrotrons usually achieve higher energy collisions than linear accelerators
Z) Electrons in circular particle accelerators emit energy over time

ANSWER: W) LARGER PARTICLE ACCELERATORS HELP STUDY MORE MASSIVE PARTICLES

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TOSS-UP

10) Math – *Short Answer* What is the period of the function $y = 13 \sin\left(\frac{\pi x}{} + 5\right)$?

ANSWER: 2

BONUS

10) Math – *Short Answer* ABCDE is a convex pentagon with right angle EAB, which is trisected by AC and AD. In addition, AB = 8, AC = 4, AD = 2, and AE = 1. What is the area of ABCDE?

ANSWER: 21/2 (ACCEPT: 10 1/2)
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TOSS-UP

11) Chemistry – *Short Answer* Identify all of the following three properties that are differences between the hexagonal close-packing of atoms and the cubic close-packing of atoms: 1) Packing efficiency; 2) Coordination number; 3) Stacking of layers.

ANSWER: 3 ONLY

BONUS

11) Chemistry – *Short Answer* Identify all of the following three processes for which the change in entropy of the system is zero: 1) Reversible adiabatic expansion; 2) Reversible isothermal compression; 3) Reversible isobaric expansion.

ANSWER: 1 ONLY

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TOSS-UP

12) Physics – *Short Answer* A car is traveling at 15 meters per second when the driver slams on the brakes, applying a constant force to decelerate to a halt in 200 meters. If, instead, the car was initially traveling at 45 meters per second, what distance in meters would be required for the car to stop with the same braking force?

ANSWER: 1800

BONUS

12) Physics – *Short Answer* Identify all of the following three conservation laws that would be violated in the decay of a neutron to a proton and an electron: 1) Conservation of charge; 2) Conservation of lepton number; 3) Conservation of spin.

ANSWER: 2 AND 3
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TOSS-UP

13) Biology – *Multiple Choice* Plasma cells, which constitute a major component of the secondary immune system by secreting antibodies, are the active form of what large group of leukocytes?

W) T-cells
X) B-cells
Y) Natural killer cells
Z) Neutrophils

ANSWER: X) B-CELLS

BONUS

13) Biology – *Short Answer* Which phylum of algae is often responsible for anoxic red tide algal blooms?

ANSWER: DINOFLAGELLATES

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TOSS-UP

14) Math – *Short Answer* Simplify the expression i^{123}.

ANSWER: $-i$

BONUS

14) Math – *Short Answer* Jeffrey rolls a fair six-sided die three times. What is the probability that he rolled a 1 at least once?

ANSWER: 91/216
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TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following is not a common characteristic of evaporite minerals?

W) They are water soluble
X) They are relatively soft
Y) Their deposition is indicative of a dry climate
Z) They are submetallic in luster

ANSWER: Z) THEY ARE SUBMETALLIC IN LUSTER

BONUS

15) Earth and Space – *Short Answer* 21 centimeter radiation is produced from a spin-flip transition of an electron between hyperfine levels of which element?

ANSWER: HYDROGEN

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TOSS-UP

16) Physics – *Short Answer* When alternating current is running through a wire, the current density is much greater at the surface of the wire than at the center, causing its resistance to increase. What is the term for this effect?

ANSWER: SKIN EFFECT

BONUS

16) Physics – *Short Answer* Moseley's law states that the atomic numbers of elements are proportional to their characteristic X-ray emission frequencies to what power?

ANSWER: 1/2
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TOSS-UP

17) Energy – *Short Answer* Researchers at Argonne National Lab are studying iron(II) chromite crystals from the Tissint Martian meteorite and its catalytic uses in the reaction of carbon monoxide and water vapor to carbon dioxide and what other gas?

ANSWER: HYDROGEN (ACCEPT: H_2)

BONUS

17) Energy – *Short Answer* Scientists at Argonne National Lab have been using Schrodinger's equation to model the electronic structure of complex organic molecules. What notation in quantum mechanics allows them to state Schrodinger's equation in terms of linear operators?

ANSWER: BRA–KET NOTATION (ACCEPT: DIRAC NOTATION)

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TOSS-UP

18) Chemistry – *Short Answer* Identify all of the following three alkene addition reactions that are considered *syn*-additions: 1) Hydroboration-oxidation; 2) Catalytic hydrogenation; 3) Bromination.

ANSWER: 1 AND 2

BONUS

18) Chemistry – *Short Answer* Water and carbon tetrachloride are added to a container. After some time, elemental iodine is dissolved in water and poured into the mixture. Once the container is shaken, what quantity describes the ratio between the concentration of iodine in the aqueous and organic phases?

ANSWER: PARTITION COEFFICIENT
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TOSS-UP

19) Math – *Short Answer* A 3 by 2 matrix is multiplied by a 2 by 4 matrix. How many entries does the resultant matrix have?

ANSWER: 12

BONUS

19) Math – *Short Answer* A particle is moving along the x axis such that it is at $x = 0$ when $t = 0$ and its velocity is given as $v(t) = t^4 - 16$. What is the positive difference between the net displacement and distance traveled in the time interval from $t = 0$ to $t = 100$?

ANSWER: 256/5

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TOSS-UP

20) Biology – *Multiple Choice* Which of the following high energy chemical species does not play a significant role in the Krebs Cycle?

W) NADPH
X) ATP
Y) NADH
Z) $FADH_2$

ANSWER: W) NADPH

BONUS

20) Biology – *Short Answer* What is the term for the gill-like lungs that spiders use for respiration?

ANSWER: BOOK LUNGS
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TOSS-UP

21) Earth and Space – *Multiple Choice* The Koppen climate classification system classifies biomes based on what two parameters?

W) Temperature and precipitation
X) Temperature and humidity
Y) Temperature and vegetation type
Z) Precipitation and vegetation type

ANSWER: W) TEMPERATURE AND PRECIPITATION

BONUS

21) Earth and Space – *Short Answer* What term is given to all the physical, chemical and biological changes that occur to sediment as they are transformed into sedimentary rock?

ANSWER: DIAGENESIS

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TOSS-UP

22) Chemistry – *Multiple Choice* In proton NMR, coupling constants are reported in what units?

W) Hertz
X) Joules
Y) Webers
Z) Parts per million

ANSWER: W) HERTZ

BONUS

22) Chemistry – *Short Answer* Certain ligands have the ability to accept electron density from filled metal *d* orbitals into their empty pi star orbitals. What term is given to this phenomenon?

ANSWER: PI BACKBONDING (ACCEPT: PI BACKDONATION)
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TOSS-UP

23) Physics – *Short Answer* What is the work done on a particle, in joules, traveling for 3 seconds in uniform circular motion with a radius of 5 centimeters and a tangential speed of 12 meters per second?

ANSWER: 0

BONUS

23) Physics – *Short Answer* What theorem in electrodynamics is analogous to the work-energy theorem in classical mechanics?

ANSWER: POYNTING'S THEOREM