SBL FALL ROUND 2

TOSS-UP

1) Chemistry – *Short Answer* Boiling occurs when the vapor pressure above a liquid becomes equal to or greater than what quantity?

ANSWER: ATMOSPHERIC PRESSURE (ACCEPT: EXTERNAL PRESSURE; DO NOT ACCEPT: PRESSURE)

BONUS

1) Chemistry – *Multiple Choice* Which of the following compounds has the lowest boiling point?

W) H_2O
X) H_2S
Y) HF
Z) PH_3

ANSWER: Z) PH_3

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TOSS-UP

2) Earth and Space – *Short Answer* What object is formed when a pulsar exceeds its TOV mass limit?

ANSWER: BLACK HOLE

BONUS

2) Earth and Space – *Multiple Choice* Which of the following moraine types is characterized by the merging of two lateral moraines?

W) End moraine
X) Medial moraine
Y) Ground moraine
Z) Shear moraine

ANSWER: X) MEDIAL MORAINE
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TOSS-UP

3) Math – *Short Answer* What is the distance between the points (8, –4) and (3, 8)?

ANSWER: 13

BONUS

3) Math – *Short Answer* What is the volume of a regular tetrahedron with a side length of 4?

ANSWER: 16 SQUARE ROOT OF 2 OVER 3

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TOSS-UP

4) Biology – *Multiple Choice* Hydroxylation of foreign substances to render them soluble occurs in which of the following organelles?

W) Rough endoplasmic reticulum
X) Smooth endoplasmic reticulum
Y) Golgi apparatus
Z) Peroxisome

ANSWER: X) SMOOTH ENDOPLASMIC RETICULUM

BONUS

4) Biology – *Short Answer* Identify all of the following three occurrences that would increase DNA expression: 1) Increase DNA methylation; 2) Decrease histone acetylation; 3) Increase histone phosphorylation.

ANSWER: 3 ONLY
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TOSS-UP

5) Physics – *Short Answer* What elementary particle is often interpreted as an electron traveling backwards in time?

ANSWER: POSITRON (ACCEPT: ANTIELECTRON)

BONUS

5) Physics – *Short Answer* A camera lens with a focal length of 40 millimeters photographs a 5 meter tall tree from a distance of 10 meters. To the nearest millimeter, how tall is the image of the tree?

ANSWER: 20

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TOSS-UP

6) Energy – *Multiple Choice* Scientists at Lawrence Berkeley National Lab are combining a series of techniques to identify and characterize all of the regulatory regions of the human genome. Which of the following is NOT an example of a regulatory region?

W) Exon
X) Promoter
Y) Silencer
Z) Enhancer

ANSWER: W) EXON

BONUS

6) Energy – *Short Answer* Scientists at Fermilab are attempting to induce pair production using Higgs bosons. Higgs bosons are theoretically able to undergo pair production because they have what charge?

ANSWER: ZERO
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TOSS-UP

7) Biology – *Multiple Choice* Which of the following is NOT needed to perform Sanger sequencing?

W) Thermocycler
X) dNTPs
Y) ddNTPs
Z) Primers

ANSWER: W) THERMOCYCLER

BONUS

7) Biology – *Short Answer* At what two amino acid residues is O-linked glycosylation most likely to occur?

ANSWER: SERINE AND THREONINE

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TOSS-UP

8) Physics – *Short Answer* The derivative of linear momentum with respect to time is equal to what physical quantity?

ANSWER: FORCE

BONUS

8) Physics – *Short Answer* A mass hangs on a string at a 45 degree angle from the vertical inside a car driving at constant speed around a circle with a radius of 10 meters. To the nearest tenth, how many meters per second is the car traveling?

ANSWER: 9.9
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TOSS-UP

9) Earth and Space – *Short Answer* X-ray bursters are commonly thought to be composed of a star and what other object?

ANSWER: PULSARS

BONUS

9) Earth and Space – *Short Answer* Identify all of the following three statements that are true of nebulae: 1) Planetary nebulae may be formed from the death of M type stars; 2) Dark nebulae can be classified as HII regions; 3) Reflection nebulae often appear red due to interstellar reddening.

ANSWER: NONE

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following acids has the strongest conjugate base?

W) Hydrofluoric acid
X) Hydrochloric acid
Y) Nitric acid
Z) Sulfuric acid

ANSWER: W) HYDROFLUORIC ACID

BONUS

10) Chemistry – *Short Answer* Identify all of the following three statements that are true regarding neutral solutions: 1) pH always equals 7; 2) pH always equals pOH; 3) As temperature increases, pH increases.

ANSWER: 2 ONLY
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TOSS-UP

11) Math – *Short Answer* What is the partial derivative with respect to x of the expression $3x^2y$?

ANSWER: $6xy$

BONUS

11) Math – *Short Answer* How many lattice points are completely inside the circle centered at (0, 0) and with radius 5?

ANSWER: 69

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TOSS-UP

12) Energy – *Multiple Choice* Scientists at Oak Ridge National Lab are attempting to characterize interactions at the liquid-liquid interface during solvent extraction. Solvent extraction is a laboratory technique in which a solute is partitioned between two immiscible solvents of greatly different polarity. Which of the following pairs of solvents may be used in solvent extraction?

W) Ethanol and methanol
X) Hexane and butane
Y) Water and diethyl ether
Z) Water and acetone

ANSWER: Y) WATER AND DIETHYL ETHER

BONUS

12) Energy – *Short Answer* Scientists at Argonne National Lab are investigating the metal-metal bonding in the rhenium-fluorine ion $Re_4F_{18}^{\ 6-}$. Indicating sign, what is the average oxidation state of the rhenium atoms in this ion?

ANSWER: +3
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TOSS-UP

13) Biology – *Short Answer* In which organ is most of the body's glycogen stored?

ANSWER: LIVER

BONUS

13) Biology – *Short Answer* Identify all of the following three regions of the brain that are derived from the hindbrain: 1) Cerebellum; 2) Thalamus; 3) Pons.

ANSWER: 1 AND 3

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TOSS-UP

14) Physics – *Short Answer* What is the equivalent resistance in ohms of a system of two resistors connected in parallel with individual resistances of 2 and 6 ohms?

ANSWER: 3/2

BONUS

14) Physics – *Short Answer* What is the term for vectors used in AC circuits to describe the frequencies and amplitude of waves graphically?

ANSWER: PHASORS
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TOSS-UP

15) Math – *Short Answer* Two sides of a triangle have lengths of 9 and 6. What is the largest possible area of the triangle?

ANSWER: 27

BONUS

15) Math – *Short Answer* An equilateral convex hexagon ABCDEF has side length 1. Angles B, D, and F are each 150 degrees, and angles A, C, and E are each 90 degrees. What is the area of this hexagon?

ANSWER: 3 PLUS ROOT 3 ALL OVER 2

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TOSS-UP

16) Earth and Space – *Multiple Choice* There is a neap tide at a beach on July 5th. When will the next spring tide be at the same beach?

W) July 6th
X) July 12th
Y) July 19th
Z) July 26th

ANSWER: X) JULY 12TH

BONUS

16) Earth and Space – *Short Answer* While studying metal sulfides, Jay finds mysterious brown cubes of goethite ***[GUR-tite]***, an iron hydroxide mineral that does not crystallize in the isometric crystal system. He believes that the goethite has replaced a sulfide mineral. What mineral has the goethite most likely replaced?

ANSWER: PYRITE
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TOSS-UP

17) Chemistry – *Short Answer* Rank the following three solids in terms of increasing band gap: 1) Lead; 2) Germanium; 3) Diamond.

ANSWER: 1, 2, 3

BONUS

17) Chemistry – *Short Answer* Rank the following three diatomic species in terms of increasing bond order as predicted by molecular orbital theory: 1) C_2^{+}; 2) N_2^{-}; 3) F_2^{2+}.

ANSWER: 1, 3, 2

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TOSS-UP

18) Math – *Multiple Choice* Which of the following is NOT true about polynomials of *x*?

W) If the degree of a polynomial is odd, then the polynomial always has a real root
X) If the degree of a polynomial is 5 or greater, then the polynomial cannot be factored over the rationals
Y) Accounting for multiplicity, the number of roots a polynomial has is the same as its degree
Z) Polynomials cannot have any terms containing *x* to a negative exponent

ANSWER: X) IF THE DEGREE OF A POLYNOMIAL IS 5 OR GREATER, THEN THE POLYNOMIAL CANNOT BE FACTORED OVER THE RATIONALS

BONUS

18) Math – *Short Answer* Alice and Bob each roll a die. What is the probability that Alice's roll is higher than Bob's roll?

ANSWER: 5/12
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TOSS-UP

19) Physics – *Short Answer* An 8-millifarad capacitor and 200-millihenry inductor are connected in series. In radians per second, what is the angular frequency of the resulting LC oscillations?

ANSWER: 25

BONUS

19) Physics – *Short Answer* A satellite of mass *m* is in an orbit of radius *r*. If *m* is doubled, then identify all of the following three quantities that also must change: 1) Orbital velocity; 2) Escape velocity; 3) Total mechanical energy.

ANSWER: 3 ONLY

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TOSS-UP

20) Earth and Space – *Short Answer* The Eddington limit refers to a limit on what property of stars?

ANSWER: LUMINOSITY

BONUS

20) Earth and Space – *Multiple Choice* Which of the following semi-permanent pressure systems would experience clockwise flow?

W) South Pacific high
X) Aleutian low
Y) Icelandic low
Z) Azores high

ANSWER: Z) AZORES HIGH
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TOSS-UP

21) Biology – *Multiple Choice* Which of the following bacteria is gram negative?

W) Bacillus anthracis
X) Clostridium botulinum
Y) Staphylococcus aureus
Z) Escherichia coli

ANSWER: Z) ESCHERICHIA COLI

BONUS

21) Biology – *Short Answer* What is the general term for inactive peptides that must be cleaved before they reach an active form?

ANSWER: ZYMOGEN

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TOSS-UP

22) Energy – *Short Answer* Researchers at Lawrence Livermore National Lab are investigating the natural dimerization of amyloid beta proteins. The aggregation of amyloid beta proteins is an indicator for what neurodegenerative disease?

ANSWER: ALZHEIMER'S DISEASE

BONUS

22) Energy – *Short Answer* Researchers at Ames Lab have developed a honeycomb vanadium lattice doped with iodine which displays ferromagnetism at 49 kelvins. However, the ferromagnetic properties of this lattice do not agree with standard mathematical models. What classical model of ferromagnetism represents discrete electron dipoles as a 2D lattice?

ANSWER: ISING MODEL
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TOSS-UP

23) Chemistry – *Short Answer* Boron trichloride is a strong Lewis acid because it is able to accept a pair of electrons into what specific empty orbital on the boron atom?

ANSWER: 2P (DO NOT ACCEPT: P)

BONUS

23) Chemistry – *Short Answer* Hydrogen bromide is added to a solution of 1-butene and then irradiated with ultraviolet light. Identify all of the following three statements that are correct regarding this reaction: 1) The reaction proceeds in an anti-Markovnikov fashion; 2) The major product is an alkyl bromide; 3) The major product is chiral.

ANSWER: 1 AND 2