SBL FALL ROUND 1

TOSS-UP

1) Chemistry – *Short Answer* Rank the following three molecules in terms of increasing bond dissociation energy: 1) Cl_2; 2) F_2; 3) HF.

ANSWER: 2, 1, 3

BONUS

1) Chemistry – *Short Answer* How many distinct carbon-carbon bond lengths are present in one molecule of 1,3-butadiene?

ANSWER: 2

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TOSS UP

2) Earth and Space – *Short Answer* Identify all of the following three features that correctly characterize shield volcanoes: 1) Relatively viscous magma; 2) Explosive eruptions; 3) Very steep profiles.

ANSWER: NONE

BONUS

2) Earth and Space – *Short Answer* The Earth's moon contains maria ***[MAR-ee-uh]***, which are various patches of dark surface thought to be volcanic in origin. Maria are composed primarily of what rock?

ANSWER: BASALT
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TOSS-UP

3) Math – *Short Answer* What is the magnitude of the vector $2\boldsymbol{i} + 2\boldsymbol{j} - 3\boldsymbol{k}$?

ANSWER: SQUARE ROOT OF 17

BONUS

3) Math – *Short Answer* What is the sum of the first 60 terms of the arithmetic sequence that has first three terms 1, 5, 9?

ANSWER: 7140

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TOSS-UP

4) Biology – *Multiple Choice* Which of the following agents does NOT act to inhibit clotting?

W) Heparins ***[hep-UH-rins]***
X) Plasmins ***[plas-mins]***
Y) Prostacyclins ***[pro-sta-SIKE-lins]***
Z) Thromboxanes ***[thh-ruhm-BO-zanes]***

ANSWER: Z) THROMBOXANES

BONUS

4) Biology – *Short Answer* Identify all of the following four vitamins that are correctly matched to symptoms or disorders of their deficiency: 1) B12 and pernicious anemia; 2) B1 and beriberi; 3) A and rickets; 4) B9 and spina bifida.

ANSWER: 1, 2, AND 4
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TOSS-UP

5) Physics – *Short Answer* A car's motion is parametrized by the position vector $r(t) = 2t^2\boldsymbol{i} - 2t\boldsymbol{j} - t^3\boldsymbol{k}$. What is the magnitude of the car's acceleration at time $t = 1/2$?

ANSWER: 5

BONUS

5) Physics – *Short Answer* What dimensionless quantity in fluid dynamics describes the resistance of a body in a viscous fluid and depends on its shape?

ANSWER: DRAG COEFFICIENT

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TOSS-UP

6) Energy – *Short Answer* Researchers at Pacific Northwest National Lab have been attempting to determine the sizes of hydrated hydronium ions that are usually surrounded by upwards of 8 water molecules. To determine these sizes, they used what class of porous minerals as molecular sieves?

ANSWER: ZEOLITES

BONUS

6) Energy – *Multiple Choice* Scientists at Argonne National Lab are developing new syntheses of two-dimensional inorganic frameworks called MXenes, which consist of early transition metals intercalated into layers of graphene. Which of the following elements is an early transition metal?

W) Titanium
X) Carbon
Y) Antimony
Z) Hydrogen

ANSWER: W) TITANIUM
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TOSS-UP

7) Biology – *Short Answer* What is the term for the respiratory systems possessed by most insects?

ANSWER: TRACHEAL SYSTEMS

BONUS

7) Biology – *Short Answer* Identify all of the following three proteins that are found in the A band of a sarcomere: 1) Actin; 2) Myosin; 3) Titin.

ANSWER: ALL

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TOSS-UP

8) Physics – *Short Answer* Identify all of the following three phenomena that are considered evidence for the particle-like nature of light: 1) Diffraction; 2) Compton scattering; 3) Photoelectric effect.

ANSWER: 2 AND 3

BONUS

8) Physics – *Short Answer* When a student shakes a piece of metal in a nonuniform magnetic field, she notices a strong resistance to its motion, as if she were pulling it through honey. What physical phenomenon is likely responsible for this?

ANSWER: EDDY CURRENTS (ACCEPT: INDUCTION)
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TOSS-UP

9) Earth and Space – *Short Answer* Rank the following three igneous minerals in terms of increasing stability to weathering at STP: 1) Olivine; 2) Quartz; 3) Hornblende.

ANSWER: 1, 3, 2

BONUS

9) Earth and Space – *Short Answer* To the nearest AU, what is the average separation between a binary system of stars with masses of 2 and 3 solar masses and an orbital period of 5 years?

ANSWER: 5

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TOSS-UP

10) Chemistry – *Multiple Choice* Manganese exists in a variety of oxidation states, all of which have diverse and distinct chemical reactivity. In which oxidation state is manganese LEAST likely to act as a reducing agent?

W) +7
X) +5
Y) +4
Z) +2

ANSWER: W) +7

BONUS

10) Chemistry – *Short Answer* For a particle in a three-dimensional cubic potential well, what is the degeneracy of the first excited state?

ANSWER: 3
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TOSS-UP

11) Math – *Short Answer* If $f(x)$ is a cubic polynomial, and $g(x)$ is a quartic polynomial, what is the degree of the polynomial f of g of x?

ANSWER: 12

BONUS

11) Math – *Short Answer* How many integer solutions are there to the equation a times b times c times d equals 1?

ANSWER: 8

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TOSS-UP

12) Energy – *Multiple Choice* Scientists at Brookhaven National Lab's Relativistic Heavy Ion Collider are using the Heavy Flavor Tracker to study the formation of hadrons under early universe conditions. Hadrons are composite particles made up of what elementary particles?

W) Gluons
X) Quarks
Y) Mesons
Z) Leptons

ANSWER: X) QUARKS

BONUS

12) Energy – *Short Answer* Scientists at Lawrence Livermore National Lab are combining quantum mechanical computations with advanced spectroscopic techniques to gauge the electrolytic properties of ionic liquids at a graphite interface. To do so, they are bombarding the ionic liquids with photons from what region of the electromagnetic spectrum?

ANSWER: X-RAY
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TOSS-UP

13) Biology – *Short Answer* A population of mice varies in their tail length, with shorter tails being advantageous for balance and longer tails being ideal for movement. If the longer-tailed phenotypes and shorter-tailed phenotypes both have higher fitness than intermediate-tailed phenotypes, what type of selection will likely occur?

ANSWER: DISRUPTIVE

BONUS

13) Biology – *Short Answer* Identify all of the following three statements that are true for all amphibians: 1) They possess four extraembryonic membranes; 2) During organogenesis, the blastopore forms the mouth; 3) They possess a pseudocoelom.

ANSWER: NONE

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TOSS-UP

14) Physics – *Multiple Choice* Which of the following statements is true regarding friction?

W) Static friction between two surfaces can vary in magnitude over time
X) Frictional forces are conservative
Y) Kinetic frictional force is often greater than static frictional force for a given surface
Z) Kinetic friction can be minimized by reducing surface contact area

ANSWER: W) STATIC FRICTION BETWEEN TWO SURFACES CAN VARY IN MAGNITUDE OVER TIME

BONUS

14) Physics – *Short Answer* When expressed mathematically, Heisenberg's uncertainty principle states that the uncertainty of momentum times the uncertainty of position is greater than or equal to one half of what constant?

ANSWER: REDUCED PLANCK'S CONSTANT (ACCEPT: H BAR; DO NOT ACCEPT: PLANCK'S CONSTANT)
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TOSS-UP

15) Math – *Short Answer* What is the slope of the inverse of the linear equation $y = 4x + 3$?

ANSWER: 1/4

BONUS

15) Math – *Short Answer* An ellipse has a major axis of 10 and a minor axis of 6. What is the closest distance from one focus to a point on the ellipse?

ANSWER: 1

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TOSS-UP

16) Earth and Space – *Multiple Choice* Which of the following planets appears the biggest from Earth at opposition?

W) Jupiter
X) Saturn
Y) Mercury
Z) Venus

ANSWER: W) JUPITER

BONUS

16) Earth and Space – *Short Answer* Identify all of the following three statements regarding body seismic waves that are true: 1) P and S waves both have respective shadow zones; 2) P waves travel faster than S waves; 3) P waves may propagate through fluids while S waves cannot.

ANSWER: ALL
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TOSS-UP

17) Chemistry – *Multiple Choice* When acetone is exposed to hydrogen gas in the presence of a metal catalyst, which of the following functional groups is most likely to form as the major product?

W) Primary alcohol
X) Secondary alcohol
Y) Ether
Z) Aldehyde

ANSWER: X) SECONDARY ALCOHOL

BONUS

17) Chemistry – *Short Answer* Rank the following three bonds in terms of increasing bond force constant: 1) Ethylene C–H bond; 2) Acetylene C–H bond; 3) Acetylene C–C bond.

ANSWER: 1, 2, 3

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TOSS-UP

18) Math – *Multiple Choice* A unit circle in the coordinate plane has the point (5, 12) on its circumference. Which of the following points could NOT also be on the circumference?

W) (4, 11)
X) (5, 10)
Y) (5, 14)
Z) (6, 10)

ANSWER: Z) (6, 10)

BONUS

18) Math – *Short Answer* If x is an integer greater than 2, and x and $x + 1$ have the same number of positive factors, what is the smallest possible value of x?

ANSWER: 14
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TOSS-UP

19) Physics – *Multiple Choice* Some thermometers contain a bimetallic strip, which bends in response to temperature changes. These two metals must differ in what property?

W) Coefficient of expansion
X) Thermal conductivity
Y) Emissivity
Z) Temperature

ANSWER: W) COEFFICIENT OF EXPANSION

BONUS

19) Physics – *Multiple Choice* In electrodynamics, the magnetic field B can be expressed as the curl of the vector potential A. This is because the B field is which of the following?

W) Divergence-free
X) Steady-state
Y) Conservative
Z) A pseudovector

ANSWER: W) DIVERGENCE-FREE

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TOSS-UP

20) Earth and Space – *Short Answer* Identify all of the following three ocean sediments that can be classified as hydrogenous: 1) Manganese nodules; 2) Turbidite deposits; 3) Calcareous ***[cal-CARE-ee-ous]*** ooze.

ANSWER: 1 ONLY

BONUS

20) Earth and Space – *Short Answer* Identify all of the following three atmospheric gases that could lead to the formation of acid rain: 1) Nitrogen dioxide; 2) Sulfur dioxide; 3) Carbon dioxide.

ANSWER: ALL
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TOSS-UP

21) Biology – *Short Answer* Following overactivation of adenylyl cyclase, cyclic AMP may be broken down into AMP by what enzyme?

ANSWER: PHOSPHODIESTERASE

BONUS

21) Biology – *Short Answer* Daniel steps on a nail, receiving external injury to his skin, and bacteria quickly take the opportunity to enter. Representing the majority of leukocytes, which class of cells is responsible for performing diapedesis and phagocytosis on the bacteria?

ANSWER: NEUTROPHILS

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TOSS-UP

22) Energy – *Multiple Choice* Scientists at Lawrence Berkeley National Lab are conducting both X-ray crystallography and X-ray emission spectroscopy experiments in order to characterize biochemical systems involved in the oxidation of water. Which of the following processes are they investigating?

W) Gluconeogenesis
X) Cellular respiration
Y) The light reactions
Z) Nucleotide biosynthesis

ANSWER: Y) THE LIGHT REACTIONS

BONUS

22) Energy – *Short Answer* Scientists at Argonne National Lab are studying trace elements in meteorites to gather clues regarding nucleosynthesis in novae. Novae generally occur in binary systems of a main sequence star and what other object?

ANSWER: WHITE DWARF
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TOSS-UP

23) Chemistry – *Multiple Choice* The reaction of methyl iodide with sodium hydroxide proceeds primarily via which of the following mechanisms?

W) SN1
X) SN2
Y) E1
Z) E2

ANSWER: X) SN2

BONUS

23) Chemistry – *Multiple Choice* Which of the following ligands may exhibit a denticity greater than one in binding to a metal center?

W) Carbonate
X) Ammonia
Y) Hydroxyl
Z) Water

ANSWER: W) CARBONATE