CSBL ROUND 6

TOSS-UP

1) Biology – *Short Answer* What cells produce testosterone in response to stimulation from luteinizing hormone?

ANSWER: LEYDIG CELLS

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BONUS

1) Biology – *Short Answer* Identify ALL of the following that are formed from tryptophan:

I. Auxin
II. Melatonin
III. Serotonin
IV. Melanin

ANSWER: I, II, III (ACCEPT: ALL BUT IV)

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TOSS-UP

2) Chemistry – *Short Answer* Identify ALL of the following that are intensive properties:

I. Helmholtz Energy
II. Gibbs Free Energy
III. Entropy

ANSWER: NONE

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BONUS

2) Chemistry – *Multiple Choice* On a phase diagram, if the solid-liquid boundary line has a POSITIVE slope, which of the following statements is TRUE:

W) Its Liquid Phase is Denser than its Solid Phase
X) Its Solid Phase is Denser than its Liquid Phase
Y) It can never form a supercooled fluid
Z) It can never form a supercritical fluid
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ANSWER: X) ITS SOLID PHASE IS DENSER THAN ITS LIQUID PHASE

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TOSS-UP

3) Physics – *Multiple Choice* Which of the following magnifications CANNOT be produced using a single CONVERGING lens?

W) ½
X) 2
Y) -½
Z) -2

ANSWER: W) ½

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BONUS

3) Physics – *Multiple Choice* Arin has just discovered a new mineral! When light travels from air to this mineral, which has an index of refraction of 0.58, at which of the following angles will the reflected ray be maximally polarized?

W) 15 degrees
X) 30 degrees
Y) 45 degrees
Z) 60 degrees

ANSWER: X) 30 DEGREES

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TOSS-UP

4) ESS – *Short Answer* What type of cooling, characterized by the conservation of heat, primarily causes cloud formation?

ANSWER: ADIABATIC

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BONUS

4) ESS – *Short Answer* Identify all of the following storm scales that use damage as a way to categorize storms:

I. Saffir-Simpson
II. Enhanced Fujita
III. Modified Mercalli

ANSWER: II ONLY

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TOSS-UP

5) Math – *Short Answer* Giving your answer in standard form, what is the equation of the line tangent to $x^2 + y^2 = 169$ at the point (5,12)

ANSWER: 5x + 12y = 169 (ACCEPT 12y + 5x = 169, do not accept any other form)

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BONUS

5) Math – *Multiple Choice* How many points with integer coordinates are in the interior of the circle whose equation is given by $x^2 + y^2 = 13$

W) 31
X) 37
Y) 41
Z) 47

ANSWER: X) 37

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TOSS-UP

6) Energy – *Short Answer* Scientists at the National Renewable Energy Lab are studying the usage of perovskites in photovoltaic devices. However, the crystal structure of perovskites may trap electrons. What quasiparticles, which are collective excitations within the structure, may explain this?

ANSWER: PHONONS

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BONUS

6) Energy – *Short Answer* Scientists at Frederick National Lab are developing ways to slow cancer progression. These techniques often involve targeting of what protein family, known for playing a role in cancer types when mutated or overexpressed?

ANSWER: CATENIN

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TOSS-UP

7) Biology – *Short Answer* Identify ALL of the following organs that are part of the female reproductive system in a flower:

I. Anther
II. Sepal
III. Style
IV. Filament

ANSWER: III ONLY

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BONUS

7) Biology – *Short Answer* John and Jill are getting married! If they are heterozygous in four genes that all follow a dominant-recessive inheritance pattern, what is the probability that the resulting child will be homozygous dominant for at least one trait?

ANSWER: 175/256

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TOSS-UP

8) Chemistry – *Short Answer* What is the term for a covalent bond between a Lewis acid and Lewis Base, characterized by both electrons migrating from the base?

ANSWER: DATIVE BOND (ACCEPT: COORDINATE COVALENT BOND)

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BONUS

8) Chemistry – *Multiple Choice* On a cubic unit cell, there are atoms on ALL of the corners, 4 of the faces, and in the center. How many atoms are contained within this unit cell?

W) 13
X) 4
Y) 2
Z) 1

ANSWER: X) 4

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TOSS-UP

9) Physics – *Short Answer* In a heat engine, the state of the working substance traces out a closed path on a PV diagram. What quantity is represented by the area enclosed by this path?

ANSWER: WORK

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BONUS

9) Physics – *Multiple Choice* A parallel plate capacitor with plate area of A and plate separation d has a capacitance of C. If the plate area is doubled to 2A and the plate separation is halved to d/2, what is the new capacitance, in terms of C?

W) C
X) 2C
Y) 4C
Z) 16C

ANSWER: Y) 4C

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TOSS-UP

10) ESS – *Short Answer* Rank the following 3 components of the Sun's atmosphere in terms of INCREASING temperature:

I. Chromosphere
II. Corona
III. Photosphere

ANSWER: III, I, II

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BONUS

10) ESS – *Short Answer* Joy has just discovered 2 new planets: Thanksgivin and Christma. She observes that the period of Thanksgivin is X years and it's semimajor axis is Y AU. She's also determined that the period of Christma is 8X years, but she's having trouble locating Christma. Based on this data, in terms of Y, what is the semimajor axis of Christma?

ANSWER: 4Y

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TOSS-UP

11) Math – *Multiple Choice* Every angle in a convex polygon is summed EXCEPT for one of them, and the result is 650 degrees. In degrees, what is the last angle?

W) 70
X) 90
Y) 110
Z) 130
ANSWER: W) 70

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BONUS

11) Math – *Short Answer* Adrian runs at a constant speed of 21 miles per hour. He starts to run for one hour, and after this hour elapses, he turns around and runs for 30 minutes. He repeats this process 2021 times, running for half of the previous time every time. To the nearest integer, how many miles is Adrian from his starting point?

ANSWER: 14

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TOSS-UP

12) Energy – *Short Answer* Scientists at Argonne National Lab are developing a probe that can sense neurotransmitters in the brain. This will allow for the investigation of neurobiological mechanisms and disease symptoms of various brain disorders. It may also be able to detect hypoxia in the brain, which causes what physiological condition?

ANSWER: STROKE
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BONUS

12) Energy – *Short Answer* Scientists at SLAC National Lab are studying the electronic structure of a metalloporphyrin ion through L-edge spectroscopy. The metal center in a metalloporphyrin is coordinated to 4 atoms of what element?

W) Nitrogen
X) Oxygen
Y) Hydrogen
Z) Iron

ANSWER: W) NITROGEN

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TOSS-UP

13) Biology – *Multiple Choice* Which of the following diseases is caused by a virus?
W) Malaria
X) Ebola
Y) Toxoplasmosis
Z) Bubonic Plague

ANSWER: X) EBOLA

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BONUS

13) Biology – *Short Answer* Identify ALL of the following 3 diseases that are sex-linked:

I. Duchenne Muscular Dystrophy
II. Hemophilia
III. Rett Syndrome

ANSWER: ALL

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TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following conditions will result in the LEAST IDEAL GAS?
W) High Pressure and High Temperature
X) Low Pressure and Low Temperature

Y) Low Pressure and High Temperature
Z) High Pressure and Low Temperature

ANSWER: Z) HIGH PRESSURE AND LOW TEMPERATURE

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BONUS

14) Chemistry – *Short Answer* The Van der Waals equation has two parameters *a* and *b*, which are modifications from the Ideal Gas equation. What do these two parameters correct for?

ANSWER: IMFS and VOLUME OF GAS (ACCEPT DESCRIPTIONS AND INVERTED ORDER)

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TOSS-UP

15) Physics – *Short Answer* Identify ALL of the following three quantities that change for a system in STATIC equilibrium:

I. Force
II. Torque
III. Linear Momentum

ANSWER: NONE

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BONUS

15) Physics – *Short Answer* Identify ALL of the following three statements that are TRUE regarding bodies under stress:

I. They are permanently deformed past their yield strength
II. They can return to their original form past their compressive strength
III. In the elastic region, the stress-strain curve is linear

ANSWER: I and III

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TOSS-UP

16) ESS – *Short Answer* What element is characterized by a doublet in its spectrum at 588 and 589 nanometers?

ANSWER: SODIUM

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BONUS

16) ESS – *Multiple Choice* Which of the following is characteristic of a Type Ia supernova?

W) Strong silicon line at 615 nm, no hydrogen lines
X) Strong silicon line at 615 nm and additional hydrogen lines
Y) Strong iron line at 810 nm, no hydrogen lines
Z) Strong hydrogen lines

ANSWER: W) Strong silicon line at 615 nm, no hydrogen lines

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TOSS-UP

17) Math – *Multiple Choice* In 2021, March 1st fell on a Monday. What is the next year that March 1st will fall on a Monday?

W) 2026
X) 2027
Y) 2028
Z) 2029

ANSWER: X) 2027

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BONUS

17) Math – *Short Answer* What is the distance between the two polar coordinates (8, 120) and (6,0)

ANSWER: $2\sqrt{37}$

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TOSS-UP

18) Energy – *Multiple Choice* Scientists at Berkeley Analytical, a part of Berkeley Lab, have recently begun emission testing for VOCS, or volatile organic compounds. Which of the following compounds is a VOC?

W) Carbon Monoxide
X) Polyethylene
Y) Carbon Dioxide
Z) Benzene
ANSWER: Z) BENZENE

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BONUS

18) Energy – *Short Answer* Scientists at Los Alamos National Lab are researching ways to mitigate wildland fires. Wildfires such as these are seen as a missing source of what carbon-containing compound, and catalyzes the formation of peptides from amino acids?

ANSWER: CARBONYL SULFIDE (ACCEPT: OCS)

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TOSS-UP

19) Biology – *Short Answer* Help! Arin's grandma has fallen and can't get up! She was taken to the hospital, where she was diagnosed with an injury to the substantia nigra and a lack of dopamine release. What neurologic disease will she likely exhibit symptoms of?

ANSWER: PARKINSON'S DISEASE

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BONUS

19) Biology – *Short Answer* During apoptosis, the release of what iron-coordinating protein in mitochondria leads to the activation of caspase enzymes?

ANSWER: CYTOCHROME C

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TOSS-UP

20) Chemistry – *Multiple Choice* Which of the following graphs represent a first-order reaction?

W) A graph of concentration vs time, which is linear
X) A graph of concentration of products vs concentration of reactants, which is linear

Y) A graph of the natural log of concentration vs time, which is linear
Z) A graph of the reciprocal of concentration vs time, which is linear

ANSWER: Y) A graph of the natural log of concentration vs time, which is linear

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BONUS

20) Chemistry – *Short Answer* Consider a zeroth-order reaction with a single aqueous reactant, X. If the initial concentration of X is 2 molar, and the half-life at this time is 10 seconds, how many seconds will elapse before the concentration is 0.5 molar.

ANSWER: 15

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TOSS-UP

21) Physics – *Short Answer* Identify ALL of the following types of materials that have higher resistance at higher temperatures:

I. Insulator
II. Semiconductor
III. Conductor

ANSWER: III ONLY

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BONUS

21) Physics – *Short Answer* Two solid spheres of radius r are in contact with each other. Given UNIFORM DENSITY, the gravitational force between the spheres is proportional to what power of r?

ANSWER: 4

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TOSS-UP

22) ESS – *Short Answer* Identify ALL of the following cycles that are Milankovitch cycles:

I. Eccentricity
II. Obliquity
III. Precession

ANSWER: ALL

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BONUS

22) ESS – *Multiple Choice* Which of the following is closest to a lunar synodic day?

W) 12 hours
X) 12 hours and 25 minutes
Y) 24 hours
Z) 24 hours and 50 minutes

ANSWER: Z) 24 HOURS AND 50 MINUTES

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TOSS-UP

23) Math – *Short Answer* What is the derivative with respect to x of f(x) = $\frac{sin(x)}{tan(x)}$

ANSWER: $-\ sin(x)$

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BONUS

23) Math – *Short Answer* What is the radius of a circle inscribed in a triangle with side lengths of 13, 15, and 18

ANSWER: $\frac{20\sqrt{23}}{23}$

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