CSBL ROUND 7

TOSS-UP

1) Biology – *Multiple Choice* Amy the budding scientist is crossing two pea plants. One pea plant is true-breeding for the dominant traits of round and yellow seeds, while the other is true-breeding for wrinkled and green seeds. What fraction of the offspring will be round and have yellow seeds?

W) 0
X) ½
Y) ⅔
Z) 1

ANSWER: Z) 1

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BONUS

1) Biology – *Short Answer* While a 9:3:3:1 phenotypic ratio for the offspring occurs when both parents are heterozygous for both traits in the dihybrid cross, a 9:7 ratio is possible. What genetic phenomenon is indicative of a 9:7 phenotypic ratio?

ANSWER: EPISTASIS

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TOSS-UP

2) Chemistry – *Multiple Choice* If the standard change in Gibbs free energy of a reaction is negative, which of the following MUST be true at standard temperature and pressure?

W) Q is greater than 1

X) Q is less than 1

Y) K is greater than 1

Z) K is less than 1

ANSWER: Y) K IS GREATER THAN 1

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BONUS
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2) Chemistry – *Short Answer* In an experimental reaction, Joy determines that the equilibrium constant is 2.72. She is trying to find **delta G** when this reaction is in equilibrium. Given that the universal gas constant is 8.314 J/mol-K and the reaction takes place at 273 degrees Kelvin, what is **delta G** at equilibrium.

ANSWER: 0

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TOSS-UP

3) Physics – *Short Answer* What law states that the gram-atomic heat capacity of an element is constant?

ANSWER: DULONG-PETIT LAW

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BONUS

3) Physics – *Multiple Choice* At sufficiently high temperatures, when vibrational modes are excited, what fraction of the thermal energy of a gas molecule is ROTATIONAL kinetic energy?

W) ⅖
X) 2/7
Y) ⅗
Z) 3/7
ANSWER: X) 2/7

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TOSS-UP

4) ESS – *Multiple Choice* Which of the following descriptions is NOT CORRECT about aa and pahoehoe.

W) Aa's surface is rough, whereas pahoehoe's is smooth
X) Pahoehoe CANNOT turn into aa, whereas aa CAN become pahoehoe
Y) Pahoehoe is hotter than aa
Z) Pahoehoe and aa can both come from the same volcano

ANSWER: X) Pahoehoe CANNOT turn into aa, whereas aa CAN become pahoehoe

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BONUS

4) ESS – *Short Answer* Some types of igneous formations can intrude into sedimentary strata, causing arching of the beds above while leaving the beds below flat. What is the term for this igneous formation?

ANSWER: LACCOLITH

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TOSS-UP

5) Math – *Multiple Choice* Kyle is trying to please all of his relatives this holiday season. When he tried to give his chocolates to 5 people, he had 3 left over. Furthermore, when he tried to distribute them to 9 people, he had 6 left over. To ensure that each and every person gets an equal number of chocolates, Arin gave him 2 more. If Kyle had tried to give his entire supply of chocolates to 10 people, how many would he have left over?

W) 2
X) 4
Y) 6
Z) 8

ANSWER: Z) 8

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BONUS

5) Math – *Short Answer* The Suns and Bucks are back in the NBA Finals, a 7-game series. Each team has a ½ probability of winning each game, and the games are independent of each other. What is the probability that the series finishes in **EXACTLY** 5 games.

ANSWER: ¼

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TOSS-UP

6) Energy – *Multiple Choice* Scientists at Brookhaven Lab have pioneered a technique of using X-ray nanovision to observe bacteria in tissue. Which of the following mechanisms is NOT used by bacteria to generate motion?

W) Surface Protein Complexes
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X) Microvilli
Y) Flagella
Z) Pili

ANSWER: X) MICROVILLI

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BONUS

6) Energy – *Multiple Choice* Scientists at Argonne National Lab are attempting to use 3-D structures to battle infectious diseases. 2 types of bacteria that they have studied are Listeria and Rickettsia. Identify ALL of the following diseases that are caused by these genera of bacteria:

I. Listeriosis
II. Rickets
III. Rocky Mountain Spotted Fever
IV. Typhus

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

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TOSS-UP

7) Biology – *Short Answer* What protein blocks myosin from binding to actin in relaxed muscles?

ANSWER: TROPOMYOSIN

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BONUS

7) Biology – *Multiple Choice* Which of the following amino acids is MOST LIKELY to be found in an alpha helix?

W) Proline
X) Serine
Y) Tyrosine
Z) Glutamic Acid

ANSWER: Z) GLUTAMIC ACID

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TOSS-UP

8) Chemistry – *Short Answer* Rank the following three acids in terms of increasing pKa:

I. Sulfuric Acid
II. Hydrobromic Acid
III. Acetic Acid

ANSWER: 2, 1, 3

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BONUS

8) Chemistry – *Multiple Choice* Arin is trying to determine the pKa of histidine. He observes that in a working muscle cell with a pH of 6.9, the ratio of the deprotonated to protonated forms of histidine is 2.5. Based on this data, which of the following is closest to the pKa of histidine?

W) 4.5
X) 5.5
Y) 6.5
Z) 7.5

ANSWER: Y) 6.5

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TOSS-UP

9) Physics – *Short Answer* What number, which is defined as the ratio of inertial forces to viscous forces within a fluid, helps predict flow patterns?

ANSWER: REYNOLDS NUMBER

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BONUS

9) Physics – *Short Answer* Adrian is performing an experiment. He increased the temperature of an ideal gas from -73 degrees CELSIUS to 177 degrees CELSIUS. By what factor does the root mean square speed of the molecules in the gas change?

ANSWER: 1.5 (ACCEPT: 3/2)

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TOSS-UP

10) ESS – *Multiple Choice* Which of the following methods of determining distances to celestial objects is useful for large distances?

W) Parallax

X) Hubble's law

Y) Cepheid Variables

Z) Radar ranging

ANSWER: X) HUBBLE'S LAW

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BONUS

10) ESS – *Multiple Choice* Which of the following is NOT true of stellar evolution and the HR diagram?

W) White dwarfs can be found in the lower left region of the HR diagram

X) The sun falls on the main sequence track

Y) The instability strip lies below the main sequence

Z) The Hayashi track is a pre-main-sequence phase of stellar evolution

ANSWER: Y) THE INSTABILITY STRIP LIES BELOW THE MAIN SEQUENCE

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TOSS-UP

11) Math – *Multiple Choice* According to the Rational Root Theorem, which of the following polynomials could have x = 4 as a root

W) $x^2 + 6x + 25$

X) $3x^2 + 4x + 6$

Y) $4x^2 + 4x + 28$

Z) $5x^2 + 15x + 30$

ANSWER: Y) $4x^2 + 4x + 28$

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BONUS

11) Math – *Short Answer* Simplify the following fraction, giving your answer in a+bi form:

$\frac{3+6i}{12-15i}$

ANSWER: $-\frac{6}{41} + \frac{13}{41}i$

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TOSS-UP

12) Energy – *Short Answer* Scientists at Argonne National Lab are studying polymeric materials that can form different solid and liquid phases. Many of these polymers involve multiple types of monomers chained together. What are these polymers with different monomers known as?

ANSWER: COPOLYMERS

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BONUS

12) Energy – *Short Answer* Scientists at Berkeley Lab are studying intracellular transport. This is accomplished by either molecular motors that pull vesicles or by what type of motion, characterized by the random motion of particles suspended in a medium?

ANSWER: BROWNIAN MOTION

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TOSS-UP

13) Biology – *Short Answer* Identify all of the following organisms that are CORRECTLY Matched with their survivorship curves:

I. Birds and Type I
II. Fish and Type II
III. Humans and Type III

ANSWER: NONE

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BONUS

13) Biology – *Multiple Choice* Adrian the Field Explorer strikes again! He just found a new type of species, and he's observed that the female is generally more showier and outgoing than the male counterpart. Which of the following adjectives best describes this type of species?

W) Polygamous
X) Polygynous
Y) Polyandrous
Z) Promiscuous

ANSWER: Y) POLYANDROUS

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TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following is NOT a colligative property?

W) Vapor Pressure Elevation
X) Osmotic Pressure
Y) Freezing Point Depression
Z) Boiling Point Elevation

ANSWER: W) VAPOR PRESSURE ELEVATION

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BONUS

14) Chemistry – *Short Answer* Rank the following solutions based on increasing MAGNITUDE of their freezing point depression.

I. A 2 molal solution of calcium chloride
II. A 4 molal solution of xenon hexafluoride
III. A 1 molal solution of sodium chloride

ANSWER: III, II, I

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TOSS-UP
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15) Physics – *Short Answer* What angle is the angle of incidence where a 90 degree angle is created between the reflected and refracted ray?

ANSWER: BREWSTER'S ANGLE

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BONUS

15) Physics – *Short Answer* A resistor is constructed using an infinite number of resistors in parallel. The first resistor has a resistance of 2 ohms, and each successive resistor has a resistance of double the previous one. What is the resistance, in ohms, of the composite?

ANSWER: 1 OHM

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TOSS-UP

16) ESS – *Multiple Choice* Who's research led to the formation of the principle of superposition?

W) Steno
X) Cuvier
Y) Hutton
Z) Ussher

ANSWER: W) STENO

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BONUS

16) ESS – *Short Answer* By name or number, identify all of the following statements that are TRUE about unconformities

I. They represent extra time
II. They represent missing time
III. They represent periods of increased deposition
IV. They represent periods of non-deposition

ANSWER: II and IV
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TOSS-UP

17) Math – *Short Answer* What is the partial derivative with respect to y of $6x^5y^3$

ANSWER: $18x^5y^2$

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BONUS

17) Math – *Short Answer* Simplify the following expression:

$sin(21)cos(21)tan(21) + sin(69)cos(69)tan(69)$

ANSWER: 1

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TOSS-UP

18) Energy – *Multiple Choice* Scientists at Pacific Northwest National Lab are studying how innovations to the process of the synthesis of catalysts can be used to greater control multidimensional catalytic structures. Which of the following quantities will INCREASE when a catalyst is added to a reaction?

W) Activation Energy
X) Change in Gibbs Free Energy
Y) Rate of Formation of Products
Z) Rate of Formation of Reactants

ANSWER: Y) RATE OF FORMATION OF PRODUCTS

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BONUS

18) Energy – *Multiple Choice* Scientists at the Joint Genome Institute are studying gene expression in metabolic pathways. Which of the following is NOT a tool used to study the expression of a gene?

W) RNA-Seq

X) qRT-PCR
Y) DNA Microarray
Z) Southern Blotting

ANSWER: Z) SOUTHERN BLOTTING

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TOSS-UP

19) Biology – *Multiple Choice* Which of the following types of stomach cells is the intrinsic factor released from?

W) Chief Cells
X) Parietal Cells
Y) Goblet Cells
Z) D Cells

ANSWER: X) PARIETAL CELLS

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BONUS

19) Biology – *Short Answer* During signal transduction, ions are released from the endoplasmic reticulum, resulting in the ions' binding and activation of signaling proteins. What type of ion is often involved in this process?

ANSWER: CALCIUM 2+ IONS (DO NOT ACCEPT: CALCIUM)

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TOSS-UP

20) Chemistry – *Short Answer* Identify ALL of the following statements that are TRUE with the titration of a strong acid with a weak base:

I. The equivalence point has a pH greater than 7
II. The half-equivalence point has the pH = pKa
III. The titration curve is STEEPEST at the start of the titration

ANSWER: II ONLY

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BONUS

20) Chemistry – *Short Answer* Given that the pKa of hydrofluoric acid is 3.1, what is the pH of a solution where 1 L of 3 M sodium hydroxide is titrated with 11 L of 3 M hydrofluoric acid.

ANSWER: 2.1

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TOSS-UP

21) Physics – *Multiple Choice* Two blocks of masses 60 and 40 kilograms are connected by a cord that passses over a frictionless pulley. What is the distance traveled to the nearest meter by the 60 kilogram block after 10 seconds.

W) 9.8
X) 49
Y) 98
Z) 196
ANSWER: Y) 98

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BONUS

21) Physics – *Multiple Choice* Which of the following particles DO NOT obey Fermi-Dirac statistics?

W) Top Quark
X) Electron
Y) Proton
Z) Gluon

ANSWER: Z) GLUON

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TOSS-UP

22) ESS – *Multiple Choice* At high latitudes, which of the following correctly describes the change in TEMPERATURE and DENSITY as you approach the surface from underwater?

W) Temperature Increases, Density Remains Constant
X) Temperature Decreases, Density Remains Constant
Y) Temperature Remains Constant, Density Decreases
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Z) Temperature remains Constant, Density Remains Constant

ANSWER: Z) Temperature remains Constant, Density Remains Constant

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BONUS

22) ESS – *Multiple Choice* Along the coast of California, when a strong wind blows in from Mexico, Ekman transport causes the movement of water towards which of the following?

W) Offshore
X) Onshore
Y) Alongside the shore, southwards
Z) Along the shore, northwards
ANSWER: X) ONSHORE

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TOSS-UP

23) Math – *Short Answer* If the surface area of a cube is 72, what is the length of its longest diagonal?

W) 2
X) 4
Y) 6
Z) 8
ANSWER: Y) 6

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BONUS

23) Math – *Short Answer* When the hexadecimal, or base 16 number, 1235654 is converted to decimal, what is its last digit?

ANSWER: 6

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