DOUGHERTY VALLEY ROUND 3

TOSS UP

1) Math *Multiple Choice* What is the sum of the distinct prime factors of 4242?

W) 106
X) 111
Y) 113
Z) 124

ANSWER: Y) 113

BONUS

1) Math *Short Answer* What is the positive real solution to the equation $\frac{1}{x-1} - \frac{1}{x+1} = \frac{1}{2}$?

ANSWER: $\sqrt{5}$

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TOSS UP

2) EARTH AND SPACE *Short Answer*: What is the name for the condition when the environmental lapse rate is between the dry adiabatic and wet adiabatic lapse rates?

Answer: Conditional instability

BONUS

2) EARTH AND SPACE *Multiple Choice*: The surface temperature of a star is 5800 K. What is the peak wavelength of radiation of this star in nanometers, assuming the star is a blackbody?

Answer: 500 nm
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TOSS UP

3) Chemistry *Multiple Choice* What is the oxidation state of Sulfur in the Sulfate anion?

ANSWER: +6

BONUS

3) Chemistry *Short Answer* In it solid state, PCl_5 is an ionic compound. According to valence shell electron repulsion theory, what are the molecular geometries around the cation and anion respectively in PCl_5?

ANSWER: Tetrahedral, Octahedral

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TOSS UP

4) BIOLOGY *Short Answer*: Which connective tissue type is the only one characterized by the presence of all fiber types and is found in widespread locations throughout the body?

ANSWER: Areolar

BONUS

4) BIOLOGY *Multiple Choice*: Which of the following is not a fiber type found in typical connective tissue extracellular matrix?

W) Elastic
X) Hyaline
Y) Reticular
Z) Collagen

ANSWER: X) Hyaline
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TOSS UP

5) Physics *Short Answer* Which principle dictates that the path which light takes through any medium from one point to another will be the path that takes the least time?

ANSWER: Fermat's principle (of least time)

BONUS

5) Physics *Short Answer* A 75 kg human is walking at 3.5 m/s. The person then accelerates at a rate of 1 m/s^2, until they reach a speed of 8.5 m/s. What is the average power exerted by the person while they were accelerating?

ANSWER: 450 W

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TOSS UP

6) EARTH AND SPACE *Multiple Choice*: Which of the following minerals is a nickel ore?

W) Cinnabar
X) Rutile
Y) Pentlandite
Z) Cassiterite

Answer: Y) Pentlandite

BONUS

6) EARTH AND SPACE *Short Answer*: A rock contains quartz, muscovite, orthoclase and plagioclase feldspar. What element is the plagioclase feldspar likely rich in?

Answer: Sodium
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TOSS UP

7) Chemistry *Multiple Choice* Which of the following compounds are insoluble in aqueous solution?

W) Glucose
X) Calcium Hydroxide
Y) Sodium Nitrate
Z) Silver Chromate

ANSWER: Z) Silver Chromate

BONUS

7) Chemistry *Short Answer* When excess ammonia is added to a solution of Copper (II) Sulfate, a royal blue complex forms. What is the oxidation state of copper in this complex?

ANSWER: +2

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TOSS UP

8) Math *Short Answer* Evaluate $\frac{7!\cdot 10!}{8!\cdot 8!}$.

ANSWER: 45/4

BONUS

8) Math *Short Answer* If $T(n) = \frac{n(n+1)}{2}$, what is the value of $T(1) + T(2) + T(3) + T(4) + T(5)$?

ANSWER: 35

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TOSS UP

9) BIOLOGY *Short Answer* What is the name of the hollow bony stalk that connects the hypothalamus to the hypophysis, AKA pituitary gland?

ANSWER: (Ethmoidal) Infundibulum

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BONUS

9) BIOLOGY *Short Answer* What term describes the finger-like projections at the ends of the fallopian tubes at the site of the ovaries which direct maturing eggs into the tubes?

ANSWER: Fimbriae

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TOSS UP

10) Physics *Multiple Choice* An ideal gas is allowed to freely expand. Which of the following is true about this free expansion?

W) Work is performed by the gas during the expansion.
X) Temperature drops as the gas expands further outward.
Y) The gas loses internal energy during the expansion.
Z) No heat is lost by the gas during the expansion.

ANSWER: Z) No heat is lost by the gas during the expansion.

BONUS

10) Physics *Short Answer* Order the following quantities from least magnitude to greatest magnitude. 1) the rms speed of hydrogen gas at room temperature 2) the most probable speed of hydrogen gas at room temperature 3) the most probable speed of helium gas at room temperature

ANSWER: 3, 2, 1
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TOSS UP

11) Math *Multiple Choice* A rectangular prism has edge lengths 3 inches, 4 inches and 5 inches. If the length of each edge is increased by 10 percent, to the nearest whole percent, by what percent will the volume of the prism increase?

W) 21
X) 30
Y) 31
Z) 33

ANSWER: Z) 33

BONUS

11) Math *Short Answer* How many integers greater than 10 are comprised of distinct odd digits and have their digits arranged in ascending order?

ANSWER: 26

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TOSS UP

12) Chemistry *Multiple Choice* Which of the following experimental conditions would not favor a unimolecular elimination mechanism between an alkyl chloride and a potentially nucleophilic base?

W) Using a polar aprotic solvent
X) Heating the reaction mixture
Y) Using a low concentration of base
Z) Using a weak base

ANSWER: W) Using a polar aprotic solvent

BONUS

12) Chemistry *Short Answer* How many distinct alkenes can be formed by heating 3- iodo-2,4 di methylpentane with Sodium Carbonate in aqueous Ethanol?

ANSWER: 2
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TOSS UP

13) EARTH AND SPACE *Multiple Choice*: Parabolic sand dunes require the presence of which of the following to form?

W) Vegetation
X) Variable winds
Y) Limited sand supply
Z) Abundant sand supply

Answer: W) Vegetation

BONUS

13) EARTH AND SPACE *Short Answer:* A yardang is formed by what erosional agent?

Answer: Wind

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TOSS UP

14) Physics *Short Answer* Two household appliances, with power ratings of 240 W and 300 W, are put in a series circuit, powered by a 120 V power source. How much current do the appliances draw from the power source?

ANSWER: 4.5 A

BONUS

14) Physics *Multiple Choice* In a series circuit consisting of an AC voltage source with angular frequency ω, an inductor with inductance L, and a capacitor with capacitance C, the graph of the current of the circuit over time lags the graph of the source voltage over time. Which of the following is true about this circuit?
W) C is greater than L.
X) ω is less than 1/sqrt(LC).
Y) L is greater than C.
Z) ω is greater than 1/sqrt(LC)

ANSWER: X) ω is less than 1/sqrt(LC).
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TOSS UP

15) BIOLOGY *Short Answer* Occam's Razor, which states that the simplest hypothesis that explains data should be selected, can be applied to which theory explaining the construction of phylogenetic trees?

ANSWER: Maximum parsimony (accept Theory of…, Tree of…)

BONUS

15) BIOLOGY *Short Answer* In bipeds, the anatomical directional terms superior and inferior describe the "head" and "foot" ends of the body. In quadrupeds, which terms correspond to the "head" and "foot" ends of the body?

ANSWER: Cranial/Caudal (must have both to get points, accept any form of conjunction between two words but make sure to specify correspondence)

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TOSS UP

16) Math *Multiple Choice* Seven consecutive even integers have a sum of 406. What is the sum of the least and the greatest of the seven integers?

W) 112
X) 116
Y) 120
Z) 124

ANSWER: X) 116
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BONUS

16) Math *Short Answer* Consider convex quadrilateral ABCD. If diagonal AC bisects diagonal BD and angle BAC is congruent to angle DAC, then which of the following three statements must be true?

1) ABCD is a parallelogram.
2) ABCD is a kite.
3) ABCD is a rhombus.

ANSWER: 2 only

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TOSS UP

17) Chemistry *Short Answer*: Dioptase is a bluish green mineral which was discovered in the late 18th century in Karagandy Province, Kazakhstan. Which of the following elements is most likely a component of Dioptase?

W) Magnesium
X) Calcium
Y) Boron
Z) Copper

Answer: Z) Copper

BONUS

17) Chemistry *Short Answer:* Dioptase is a cyclosilicate, meaning it contains a chain of silicate groups in a ring. What is the ratio of Oxygen atoms to Silicon atoms in a generic cyclosilicate skeleton?

Answer: 3:1
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TOSS UP

18) BIOLOGY *Short Answer* Which of the following sugars are not part of the pentose-phosphate pathway at any stage?

W) Sedoheptulose
X) Erythrose
Y) Xylulose
Z) Mannose

ANSWER: Z) Mannose

BONUS

18) BIOLOGY *Short Answer* Hemoglobin's quaternary structure consists of two alpha proteins and two beta proteins, which is arranged in two alpha-beta oligomers. What term corresponds to a repeating oligomer motif?

ANSWER: Protomer

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TOSS UP

19) EARTH AND SPACE *Short Answer*: Which of the following is not a form of hard stabilization of coastlines?

W) Breakwater
X) Jetty
Y) Groin
Z) Dredging Boat

Answer: Z) Dredging Boat
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BONUS

19) EARTH AND SPACE *Short Answer:* What are the four main elements found in most samples of olivine, considering it's position on Bowen's reaction series.

Answer: Silicon, Oxygen, Iron, Magnesium

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TOSS UP

20) Physics *Short Answer* What principle of quantum mechanics states that, for very large quantum numbers, a quantum system should begin to agree with their classical equivalents?

ANSWER: Correspondence principle

BONUS

20) Physics *Multiple Choice* In the liquid drop model of the nucleus, the energy due to repulsion of the protons in a nucleus is estimated using atomic number (Z) and mass number (A). Which of the following expressions is proportional to this estimated repulsion?

W) Z(Z - 1) / (A^(2 / 3))
X) Z(Z - 1) / (A ^ (1/3))
Y) Z(Z - 1)
Z) Z / A

ANSWER: X) Z(Z - 1) / (A ^ (1/3))

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TOSS UP

21) EARTH AND SPACE *Short Answer*: What is the term for a large metamorphic mineral crystal that has formed after its surrounding small crystals?

Answer: Porphyroblast

BONUS

21) EARTH AND SPACE *Short Answer:* What mineral group is most commonly found in porphyroblasts of metamorphic rocks?

Answer: Garnet

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TOSS UP

22) Math *Multiple Choice* Brian starts running at a speed of 5 mi/h. Two minutes later, Carla starts running along the same route as Brian. If it takes Carla 10 minutes to catch up to Brian, at what speed is Carla running, in miles per hour?

W) 27/5
X) 60/11
Y) 11/2
Z) 6

ANSWER: Z) 6

BONUS

22) Math *Short Answer* The product of 312 and x is a perfect square. What is the least possible positive integer value of x?

ANSWER: 78
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TOSS UP

23) Chemistry *Multiple Choice* Which of the following bases could deprotonate ethanol in high yield?

W) Sodium Hydroxide
X) Sodium Hydride
Y) Sodium Acetate
Z) Sodium Phenoxide

ANSWER: X) Sodium Hydride

BONUS

23) Chemistry *Short Answer* Coulomb's law predicts that the force of attraction between 2 ions in the gas phase decreases inversely proportionally to r^2 (**read as:** r squared). The force of attraction between an ion and a polar molecule decreases inversely proportionally to r to what power?

ANSWER: 3

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TOSS UP

24) BIOLOGY *Short Answer* What is the name of the root hair analogue in bryophytes and algae that serve in water absorption and aid the process of capillary action?

ANSWER: Rhizoid

BONUS

24) BIOLOGY *Short Answer* What bacterial class are the genera Streptococcus, Staphylococcus, and Listeria found under?

ANSWER: Bacilli
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TOSS UP

25) Physics *Short Answer* A ball which is initially at rest explodes, sending two fragments of masses m and 5m in opposite directions. What is the ratio of the kinetic energy of the less massive fragment to that of the more massive fragment?

ANSWER: 5 : 1

BONUS

25) Physics *Short Answer* A thin hoop of mass 2 kg and radius 3 m rolls down a ramp with a length of 20 m and an angle of 30 degrees. Assuming that g is 10 m/s^2, what is the speed of the hoop at the bottom of the ramp?

ANSWER: 10 m/s