DOUGHERTY VALLEY ROUND 2

TOSS UP

1) Math *Multiple Choice* Find the definite integral $\int_1^2 \ln x dx$.

W) $2\ln 2 - 3$
X) $2\ln 2 - 2$
Y) $2\ln 2 - 1$
Z) $2\ln 2$

ANSWER: Y) $2\ln 2 - 1$

BONUS

1) Math *Short Answer* Daniel has eight letter tiles which spell the word KOREABOO. If he randomly arranges the eight tiles in a random order, what is the probability that the arrangement spells KOREABOO correctly? Express your answer as a common fraction.

ANSWER: 1/6720

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TOSS UP

2) EARTH AND SPACE *Multiple Choice*: Which of the following properties would least likely be used to differentiate between calcite and halite?

W) Birefringence
X) Taste
Y) Hardness
Z) Crystal habit

Answer: Y) Hardness
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BONUS

2) EARTH AND SPACE *Short Answer*: The air temperature in a room is 25 degrees C, and the dew point is 15 degrees C. Approximate the relative humidity in the room.

Answer: 50%

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TOSS UP

3) Chemistry *Multiple Choice* Which of the following molecules would not exhibit a pi bond?

W) Difluorine
X) Ethene
Y) Dinitrogen
Z) Dioxygen

ANSWER: W) Difluorine

BONUS

3) Chemistry *Short Answer* Which of the following types of bonds could hypothetically be formed from the overlap of a d-orbital and a f-orbital

1) sigma bond
2) pi bond
3) delta bond
4) phi bond

ANSWER: 1, 2, 3
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TOSS UP

4) BIOLOGY *Multiple Choice*: Which of the following neurotransmitters or hormones would not be classified as a catecholamine?

W) Epinephrine
X) Acetylcholine
Y) Norepinephrine
Z) Dopamine

Answer: X) Acetylcholine

BONUS

4) BIOLOGY *Multiple Choice*: Which cranial nerve is responsible for bringing signals regarding static and dynamic balance in the body to the brain?

W) Hypoglossal
X) Vagus
Y) Vestibulocochlear
Z) Accessory

Answer: Y) Vestibulocochlear

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TOSS UP

5) Physics *Short Answer* A car is moving at 20 m/s towards a person who is standing 200 m away. The driver sees the person after some time, and begins braking at an acceleration of -10 m/s^2. If the car stops just in front of the person, how long did it take for the driver to see the person and start braking?

ANSWER: 9 s
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BONUS

5) Physics *Short Answer* Two electric charges with charges of -1 coulomb and 1 coulomb lie on a coordinate grid at (-1, 0) and (1, 0) respectively. Rank the following locations from least to greatest change in potential energy when moving a positive charge from an (0, 0) to that location.

1) (-0.5, 0)
2) (-1.5, 0)
3) (0.5, 0)
4) (1.5, 0)

ANSWER: 2, 1, 3, 4

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TOSS UP

6) Math *Multiple Choice* Find $((\sqrt{6}+\sqrt{2})+(\sqrt{6}-\sqrt{2})i)^6$.

W) $16\sqrt{3}+48i$
X) $64\sqrt{3}+192i$
Y) 2048
Z) 4096

ANSWER: Z) 4096

BONUS

6) Math *Short Answer* Let the ellipse that has foci at (1, 2) and (1, 8) and passes through the point (5, 5) have standard-form equation $\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$. Find $h+k+a+b$.

ANSWER: 15
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TOSS UP

7) EARTH AND SPACE *Multiple Choice*: A water sample is tested for pH and nitrate content. The pH yields a result of 7 and the nitrate content 250 ppm. In what environment did this water most likely originate?

W) River mouth
X) Ocean
Y) Rainwater
Z) Mountainous lake

Answer: W) River mouth

BONUS

7) EARTH AND SPACE *Short Answer*: What is the sodium endmember of the plagioclase feldspar solid solution series?

Answer: Albite

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TOSS UP

8) Chemistry *Multiple Choice* Which of the following compounds is the most polar?
W) 1,2 dichlorobenzene
X) 1,3 dichlorobenzene
Y) 1,3 diiodobenzene
Z) 1,4 diiodobenzene

ANSWER: W) 1,2 dichlorobenzene

BONUS

8) Chemistry *Short Answer* Rank the following compounds in order of increasing solubility in water:

1) Dichloromethane
2) Carbon Tetrachloride
3) Chloroform

ANSWER: 2,3,1
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TOSS UP

9) BIOLOGY *Short Answer*: Give the name of the disease that results from an insertion of the nucleotide triplet of CAG multiple times on chromosome 4 and typically results in middle-aged to late neurological problems including unsteady gait, tremor, and dementia.

Answer: Huntington's Disease

BONUS

9) BIOLOGY *Multiple Choice*: Which amino acid has an analogue with a selenium ligand?
W) Glycine
X) Phenylalanine
Y) Proline
Z) Cysteine

Answer: Z) Cysteine

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TOSS UP

10) Physics *Multiple Choice* A person is playing an organ at sea level. The person then takes that organ up to the summit of a mountain, where the temperature is half of that at sea level on the Kelvin scale, and the air pressure is also half of that at sea level. By what factor will the frequency of the organ be multiplied?
W) 1/4
X) 1/2
Y) sqrt(2) / 2
Z) 1

ANSWER: Y) sqrt(2) / 2
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BONUS

10) Physics *Short Answer* Murray Gell-Mann proposed ways to organize baryons and mesons into diagrams such as the baryon decuplet and the eightfold way. List all of the following properties that Gell-Mann use to organize these particles.

1) Charge
2) Mass
3) Spin
4) Strangeness

ANSWER: 1, 4

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TOSS UP

11) Math *Short Answer* Determine $\sin 15° \sin 45° - \sin 75° \cos 45°$.

ANSWER: -1/2

BONUS

11) Math *Multiple Choice* Find the absolute value of the slope of either asymptote of the hyperbola with a horizontal transverse axis, its center at (5, 8), a center-to-vertex distance of 8, and a center-to-focus distance of 17.

W) 8/17
X) 8/15
Y) 15/8
Z) 17/8

ANSWER: Y) 15/8
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TOSS UP

12) EARTH AND SPACE *Multiple Choice*: Nacreous clouds form in what layer of the atmosphere?

W) Troposphere
X) Stratosphere
Y) Mesosphere
Z) Thermosphere

Answer: X) Stratosphere

BONUS

12) EARTH AND SPACE *Short Answer:* What is the name for polar mesospheric clouds when observed from the ground?

Answer: Noctilucent Clouds

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TOSS UP

13) Chemistry *Short Answer* How many nodes does a 2s orbital possess?

ANSWER: 1

BONUS

13) Chemistry *Multiple Choice* Which of the following metals could not be isolated from its ore by heating it with coke at high temperature

W) Iron
X) Zinc
Y) Calcium
Z) Copper

ANSWER: Y) Calcium
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TOSS UP

14) BIOLOGY *Short Answer*: Give the name of the steroid-analogue hormones in plants responsible for promotion of cell elongation, pollen tube formation, and acceleration of senescence.

Answer: Brassinosteroids

BONUS

14) BIOLOGY *Multiple Choice*: Which form of water transport does the Casparian strip block?

W) Apoplast- water can't pass through the intercellular medium via cell wall
X) Symplast-water can't pass through the cytoplasm of neighboring cells
Y) Apoplast- water can't pass through the cytoplasm of neighboring cells
Z) Symplast- water can't pass through the intercellular medium via cell wall

Answer: W) Apoplast- water can't pass through the intercellular medium via cell wall

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TOSS UP

15) Physics *Multiple Choice* Which of the following units can NOT be used to measure the strength of a magnetic field?

W) webers per meter squared
X) newtons per ampere-meter
Y) henry-amperes
Z) kilograms per coulomb-second

ANSWER: Y) henry-amperes

BONUS

15) Physics *Short Answer* Two light beams of the same frequency interfere with each other. The second light beam is out of phase by 90 degrees from the first light beam. If the intensity of both of the light beams is 40 W/m^2, what is the phase with respect to the first light beam and the intensity of the resulting beam?

ANSWER: 45 degrees, 80 W/m^2
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TOSS UP

16) Math *Short Answer* Which of the following three functions are injective?

1) $\arctan(-x)$
2) $\arctan(\sin x)$
3) $\arctan(1 + \tan x)$

ANSWER: 1

BONUS

16) Math *Multiple Choice* Evaluate the second nonzero term of the Maclaurin series for the function $\arctan x$ at $x = 1$.

W) -1/2
X) -1/3
Y) 1
Z) -1

ANSWER: X) -⅓

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TOSS UP

17) EARTH AND SPACE *Short Answer* Name the force that counters the forces of gravity in a white dwarf.

Answer: Electron degeneracy pressure

BONUS

17) EARTH AND SPACE *Short Answer* List all of the following plate boundaries that are divergent.

1) Pacific plate-Nazca plate boundary
2) Australian-Indian plate-Antarctic plate boundary
3) Nazca plate-South American plate boundary

Answer: 1, 2
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TOSS UP

18) Chemistry *Short Answer* A reversible reaction has a forward reaction rate constant of 0.10 M s^{-1} and a reverse reaction rate constant of 10.3 s^{-1}. To the nearest hundredth place, what is the value of the equilibrium constant for the reaction?

ANSWER: 0.01

BONUS

18) Chemistry *Multiple Choice* Proton Nuclear Magnetic Resonance Spectroscopy is a common research technique for determining the structure of molecules. Which of the following functional groups would show the highest chemical shift for its proton when an NMR spectroscopy is conducted on a molecule containing it.

W) Aldehyde
X) Terminal Alkyne
Y) Carboxylic Acid
Z) Phenol

ANSWER: Y) Carboxylic Acid

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TOSS UP

19) BIOLOGY *Short Answer*: Give the name of the structure that creates a protective cover for the gills of fish and aids in water transport, respiration, and feeding.

Answer: Operculum
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BONUS

19) BIOLOGY *Multiple Choice*: The scolex is the posterior tip of the animals classified in the subphylum Cestoda. Which phylum does this fall under?

W) Nematoda
X) Rotifera
Y) Platyhelminthese
Z) Chordata
Answer: Y) Platyhelminthese

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TOSS UP

20) Physics *Multiple Choice* A racecar driver is driving around a track with a helium-filled balloon tied to the passenger seat. From the driver's perspective, which way will the balloon accelerate?

W) Towards the center of the track
X) Does not accelerate
Y) Outwards from the center of the track
Z) Downwards toward the floor of the car

ANSWER: W) Towards the center of the track

BONUS

20) Physics *Short Answer* A simple pendulum is made with a massless string of length L and a particle with mass m at the end of the string. List all of the following actions that would increase the angular frequency of the pendulum.

1) Increasing gravitational acceleration
2) Replacing particle and string with a uniform rod of mass m and length L
3) Replacing the particle with another particle that is of mass m/2 and replacing the string with another massless string that is of length L/2.

ANSWER: 1, 2, 3
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TOSS UP

21) Math *Short Answer* If 3^n is a factor of 10^9-1, what is the greatest possible integer value of n?

ANSWER: 4

BONUS

21) Math *Short Answer* Evaluate the following indefinite integral: $\int \frac{100}{36+25x^2}\,dx$

[Read as: integral of the function with numerator one hundred and denominator thirty six plus twenty five x squared d x]

ANSWER: $\frac{10}{3}\arctan(\frac{5}{6}x) + C$

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TOSS UP

22) EARTH AND SPACE *Short Answer* Due to the precession of the spin of the Earth, the North Star changes throughout time. About 6000 years ago, Thuban was the star closest to the north pole. Which of the following is closest to the number of years from now until Thuban is the star closest to the north pole again?

W) 6000
X) 20,000
Y) 40,000
Z) 100,000

Answer: X) 20,000

BONUS

22) EARTH AND SPACE *Short Answer* Order the following minerals from low to high melting temperatures according to Bowen's reaction series.

1) Pyroxene
2) Amphibole
3) Muscovite

Answer: 3, 2, 1
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TOSS UP

23) Chemistry *Multiple Choice* Which of the following nucleophiles and electrophiles respectively would be ideal to ensure a unimolecular substitution reaction

W) Sodium Hydroxide and n-Butyl Bromide
X) Sodium Hydroxide and tert Butyl Bromide
Y) Sodium Cyanide and n-Butyl Bromide
Z) Sodium Cyanide and tert Butyl Bromide

ANSWER: Z) Sodium Cyanide and tert Butyl Bromide

BONUS

23) Chemistry *Short Answer* Rank the pH of solutions containing the following ions in increasing order

1) 1.0 M H_3PO_4 and 2.2 M NaH_2PO_4
2) 1.0 M HCN and 0.10 M NaCN
3) 1.0 M NH_4Cl

ANSWER: 1), 3), 2)

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TOSS UP

24) BIOLOGY *Multiple Choice*: All of the following can be attached to a phosphatidyl group to form a membrane lipid except:

W) Serine
X) Choline
Y) Alanine
Z) Inositol

Answer: Y) Alanine
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BONUS

24) BIOLOGY *Multiple Choice*: All of the following are proteins involved in endocytosis except:

W) Caveolin
X) Clathrin
Y) Coatomer
Z) Cadherin

Answer: Z) Cadherin

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TOSS UP

25) Physics *Short Answer* The Cowan-Reines experiment confirmed the existence of which particle?

ANSWER: neutrino

BONUS

25) Physics *Short Answer* A worker is pushing a 10 kg box across the ground, which has a kinetic friction coefficient of 0.6. If the worker is pushing the box at a constant velocity of 2 m/s, what is the power being exerted by the worker on the box?

ANSWER: 117.6 W
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