DOUBLE ELIMINATION 2

TOSS-UP

1) X-Risk - *Short Answer* What element common in radioactive fallout is particularly dangerous because its chemical similarity to calcium allows it to replace structural support in human bone?

ANSWER: Strontium

BONUS

1) X-Risk - *Short Answer* Scientists believe that CRISPR gene drives can be designed for viruses and help reduce their infectivity. The insertion of these gene drives relies on what form of double-stranded DNA break repair, which is more accurate than NHEJ?

ANSWER: Homology directed repair (ACCEPT: HDR, homologous recombination)

TOSS-UP

2) Math - *Short Answer* Convert the Cartesian coordinates $(4, 4\sqrt{3})$ [four comma four root three] into polar coordinates.

ANSWER: $(8, \pi/3)$

BONUS

2) Math - *Short Answer* How many trailing zeros does 10 factorial have when it is represented in base 6?

ANSWER: 4

TOSS-UP

3) Chemistry - *Short Answer* In IR spectroscopy, what property of a molecule's vibrational mode must change for the mode to be considered as IR active?

ANSWER: Dipole moment

BONUS

3) Chemistry - *Multiple Choice* In a molecule of phosphorus pentachloride, which of the following is closest to the average phosphorus chlorine bond order?

W) 0.67
X) 0.8
Y) 1.0
Z) 1.2

ANSWER: X) 0.8

TOSS-UP

4) Earth and Space - *Multiple Choice* By what factor would a tsunami's wave speed change when it moves from water 4 kilometers deep to water 1 kilometer deep?

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

ANSWER: Y) 1/2

BONUS

4) Earth and Space - *Short Answer* Identify all of the following three features that are results of differential erosion: 1) Blowouts; 2) Yardangs; 3) Desert pavement.

ANSWER: 2 only

TOSS-UP

5) Biology - *Multiple Choice* Greycen has been prescribed oxymetazoline [ox-ee-met-uh-ZOLE-een], a type of beta blocker, from Dr. Tyler. Which of the following medical conditions does he likely have?

W) Hypertension
X) Atherosclerosis [ath-ur-oh-scler-OH-sis]
Y) Nasal congestion
Z) Hyperglycemia [hy-per-gly-SEE-mee-uh]

ANSWER: W) Hypertension

BONUS

5) Biology - *Short Answer* Identify all of the following three statements that are true of peptide bonds: 1) The peptide alpha carbon to nitrogen bonds contain partial double bond character; 2) There is rotation about the bond from the amide group to the alpha carbon; 3) Peptide bonds between glycine residues exhibit the highest number of allowed conformations on a Ramachandran plot.

ANSWER: 2 and 3

TOSS-UP

6) Physics - *Short Answer* What is the term for the special type of vector that relates circular motion to sinusoidal motion on a diagram?

ANSWER: Phasor

BONUS

6) Physics - *Short Answer* The partial derivative of entropy with respect to what thermodynamic quantity at constant volume is used to define temperature?

ANSWER: Internal energy

TOSS-UP

7) X-Risk - *Short Answer* Scientists are concerned that the effects of ice sheet melt are slowly shutting down what system of ocean currents in the Atlantic, responsible for forming the North Atlantic Deep Water?

ANSWER: Atlantic meridional overturning circulation (ACCEPT: AMOC)

BONUS

7) X-Risk - *Multiple Choice* The 2010 eruptions of Eyjafjallajokull [AY-ya-fya-la-YO-kull] in Iceland caused significant air travel disruption across Europe due to the hazards the volcanic ash had on airplane engines. Which of the following was NOT a contributing factor to the widespread closure of European airspace in response to these eruptions?

W) The eruptions occurred beneath glacial ice, which cooled the lava to form fine glass and ash
X) Hot steam sent ash into the upper atmosphere where airplanes cruise
Y) Europe saw a high number of storms around this time, which caused volcanic ash to fall to the ground
Z) The unusually stable jet stream spread ash over much of mainland Europe

ANSWER: Y) Europe saw a high number of storms around this time, which caused volcanic ash to fall to the ground

TOSS-UP

8) Math - *Short Answer* Let A be a 50×50 matrix such that A squared is equal to 0. What is the largest possible rank of A?

ANSWER: 25

BONUS

8) Math - *Short Answer* Triangle *ABC* has side *AB* with length 8, side *AC* with length $6\sqrt{2}$, and angle *A* measuring 45 degrees. What is the tangent of angle *B*?

ANSWER: 3

TOSS-UP

9) Chemistry - *Multiple Choice* A chemist wants to determine the temperature of a reversible isothermal process. The chemist plots the heat of the process along the y-axis against the entropy of the process along the x-axis to create a line. Which of the following quantities represents the temperature of this process?

W) Slope of the line
X) Inverse of slope of the line
Y) y-intercept of the line
Z) Inverse of y-intercept of the line

ANSWER: W) Slope of the line

BONUS

9) Chemistry - *Short Answer* What constant in the Born-Mayer equation relates to the lattice geometry and is a modification to the electrostatic potential of an ion within an infinite lattice?

ANSWER: Madelung constant

TOSS-UP

10) Earth and Space - *Short Answer* Type II-P [two-P] supernovae undergo silicon burning right before becoming a supernova, and have peculiar light curves due to the radioactive decay of cobalt-56 to iron-56. Which isotope, which is the endpoint of the silicon burning process, does the cobalt in the star originate from?

ANSWER: Nickel-56

BONUS

10) Earth and Space - *Short Answer* The cores of cannibalized dwarf galaxies are thought to stay gravitationally bound together, becoming what type of object in the larger galaxy?

ANSWER: Globular cluster

TOSS-UP

11) Biology - *Short Answer* In grasses such as maizes, the scutellum is analogous to what seed organ in bean plants?

ANSWER: Cotyledon

BONUS

11) Biology - *Short Answer* What method, which is used to sequence amino acids in a peptide, reacts the N-terminus of the peptide with phenyl isothiocyanate [FEEN-ul eye-soh-thy-oh-SY-uh-nate]

ANSWER: Edman degradation

TOSS-UP

12) Physics - *Short Answer* The J/Ψ [J psi] meson is expected to melt beyond what temperature, the temperature at which all hadronic matter is expected to convert into quark matter?

ANSWER: Hagedorn temperature

BONUS

12) Physics - *Multiple Choice* A cloud of gas has an ideal gas equation given as $p = \frac{\rho RT}{m}$ [p equals rho R T over M] where ρ [rho] is the constant density of the cloud and m is the individual mass of each gas molecule. The phase speed in the cloud would then be proportional to what power of temperature?

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

ANSWER: X) 1/2

TOSS-UP

13) X-Risk - *Multiple Choice* Which of the following best describes the sensitivity of a test that measures the presence or absence of a condition?

W) Probability of a positive test result, conditioned on the individual truly being positive
X) Probability of a positive test result, conditioned on the individual actually being negative
Y) Probability of a negative test result, conditioned on the individual truly being negative
Z) Probability of a negative test result, conditioned on the individual actually being positive

ANSWER: W) Probability of a positive test result, conditioned on the individual truly being positive

BONUS

13) X-Risk - *Short Answer* What measure is defined as the harmonic mean of the precision and recall of a statistical test, and has broad applications in natural language processing literature, such as in the evaluation of named entity recognition and word segmentation?

ANSWER: F-score

TOSS-UP

14) Math - *Short Answer* The scores on the final exam of a statistics class had a mean of 23 and a variance of 16. What is the z-score of a test with a score of 35?

ANSWER: 3

BONUS

14) Math - *Short Answer* A car with an initial speed of 20 miles per hour is constantly accelerating at 1 mile per hour squared. When it reaches its final destination, it is driving at 30 miles per hour. What fraction of the distance did the car travel in the first 4 hours?

ANSWER: 44/125

TOSS-UP

15) Chemistry - *Short Answer* In post-transition metals, what effect describes the tendency of outer shell s-electrons to not participate in ionic bonding?

ANSWER: Inert pair effect

BONUS

15) Chemistry - *Multiple Choice* The ring-opening reaction of an epoxide [uh-POX-ide] with which of the following ions has the lowest equilibrium constant?

W) Methyl
X) Chloride
Y) Hydronium
Z) Hydroxide

ANSWER: X) Chloride

TOSS-UP

16) Earth and Space - *Multiple Choice* Which of the following does not explain why the northern hemisphere consistently has higher CO2 concentrations than the southern hemisphere?

W) Interhemispheric mixing times are too long to homogenize the two hemispheres' carbon content
X) The northern hemisphere has a larger population
Y) The southern hemisphere has a larger ocean surface area
Z) The southern hemisphere experiences less deforestation

ANSWER: Z) The southern hemisphere experiences less deforestation

BONUS

16) Earth and Space - *Short Answer* Order the following three oceanic boundaries by increasing depth: 1) Aragonite compensation depth; 2) Aragonite saturation horizon; 3) Calcite compensation depth.

ANSWER: 2, 1, 3

TOSS-UP

17) Biology - *Short Answer* Order the following three ions by increasing contribution to membrane potential in a human neuron at resting potential: 1) K+; 2) Na+; 3) Cl-.

ANSWER: 3, 2, 1

BONUS

17) Biology - *Short Answer* Identify all of the following three that are functions of strigolactones [strig-oh-LAC-tones]: 1) Attract mycorrhizal [my-cor-RIZE-ul] fungi to roots; 2) Control of apical [AY-pic-ul] dominance; 3) Promote xylem differentiation and inhibit phloem differentiation.

ANSWER: All

TOSS-UP

18) Physics - *Multiple Choice* How many unique normal modes of oscillation exist for a system of two blocks connected by a spring traveling in the x-direction with some velocity v?

W) 1
X) 2
Y) 3
Z) 4

ANSWER: X) 2

BONUS

18) Physics - *Short Answer* Identify all of the following three statements that are necessarily true for a solenoid with a time-dependent current: 1) The vector potential outside the solenoid is zero; 2) The electric field inside the solenoid is zero; 3) The electric field outside the solenoid is non-zero.

ANSWER: None

TOSS-UP

19) X-Risk - *Short Answer* Rank the following three pathogens by increasing biosafety level needed to contain them: 1) Ebola; 2) HIV; 3) Tuberculosis.

ANSWER: 2, 3, 1

BONUS

19) X-Risk - *Short Answer* Identify all of the following three antibiotics for which ribosome protecting proteins could contribute to antibiotic resistance: 1) Aminoglycosides [a-mee-noh-GLY-coh-sides]; 2) Penicillins; 3) Tetracyclines [tet-ruh-SY-cleens].

ANSWER: 1 and 3

TOSS-UP

20) Math - *Short Answer* How many times in one day from 12am to 11:59pm inclusive do the hour and minute hands point the same direction?

ANSWER: 22

BONUS

20) Math - *Short Answer* What is the second derivative of the function $\tan(4x)$?

ANSWER: $32\sec^2(4x)\tan(4x)$

TOSS-UP

21) Chemistry - *Multiple Choice* In IR spectroscopy, the wavenumber of the carbon-fluorine single bond is closest to the wavenumber of which of the following bonds?

W) Carbon-hydrogen single bond
X) Carbon-carbon single bond
Y) Carbon-carbon double bond
Z) Carbon-carbon triple bond

ANSWER: X) Carbon Carbon single bond

BONUS

21) Chemistry - *Short Answer* Order the following three types of carbon-hydrogen single bonds by increasing bond dissociation energy: 1) Primary carbon-hydrogen bond in propene; 2) Primary carbon-hydrogen bond in propane; 3) Tertiary carbon-hydrogen bond in 2-methylpropane.

ANSWER: 1, 3, 2

TOSS-UP

22) Earth and Space - *Short Answer* Identify all of the following three changes that can contribute to the optical effect of limb darkening observed from stars as their radius gets larger: 1) Decreased atmospheric opacity; 2) Decreased atmospheric temperature; 3) Increased magnetic starspot interference.

ANSWER: 2 only

BONUS

22) Earth and Space - *Multiple Choice* Which of the following best explains why some stellar remnants may reach escape velocities from a galaxy following a supernova?

W) Not all supernovae are symmetric
X) Angular momentum in a binary must be conserved
Y) Mass loss allows the stellar remnant to gain speed
Z) Gamma ray bursts are unidirectional and create an impulse on the star

ANSWER: W) Not all supernovae are symmetrical

TOSS-UP

23) Biology - *Short Answer* Hemolytic [hee-moh-LIT-ic] diseases of the newborn is caused by the difference in the presence of which factor found in the fetus but not the mother?

ANSWER: Rhesus factor (ACCEPT: Rh factor)

BONUS

23) Biology - *Short Answer* Identify all of the following three statements that are true about glial cells in the brain: 1) They retain the ability to divide throughout adult life; 2) Ependymal [uh-PEN-duh-mul] cells are a type of glial cell; 3) They are responsible for most cancers of the brain.

ANSWER: All

TOSS-UP

24) Physics - *Short Answer* The motion of an electron's magnetic dipole about the nucleus leading to a shift in electron energy levels is known as what phenomenon?

ANSWER: Spin-orbit coupling

BONUS

24) Physics - *Short Answer* Identify all of the following three metals that would have electrons ejected due to the photoelectric effect if red light with a wavelength of 600 nanometers shone on it, assuming Planck's constant is 6.6×10^{-34} joule seconds: 1) Cesium with a work function of 2.1 electron volts; 2) Nickel with a work function of 4 electron volts; 3) Cobalt with a work function of 5 electron volts.

ANSWER: 1 only