

DOUBLE ELIMINATION ~ ROUND 3

TOSS UP

1. CHEMISTRY *Multiple Choice* Which of the following protons will have the largest coupling constant in the $^1\text{H-NMR}$ spectrum?

- W) Cis-alkene
- X) Trans-alkene
- Y) Ortho-benzene
- Z) Para-benzene

ANSWER: X) TRANS-ALKENE

BONUS

1. CHEMISTRY *Multiple Choice* Which of the following polymers is soluble in organic solvents and rigid?

- W) Low density polyethylene [*pol-ee-ETH-uh-leen*]
- X) Atactic polypropylene [*pol-ee-PROH-puh-leen*]
- Y) Polystyrene [*pol-ee-STY-reen*]
- Z) Polyvinyl chloride [*pol-ee-VYNL*]

ANSWER: Y) POLYSTYRENE

TOSS UP

2. BIOLOGY *Multiple Choice* With regard to leaf abscission, which of the following two plant hormones are antagonistic?

- W) Ethylene and auxin [*ETH-uh-leen and AWK-sin*]
- X) Gibberellin and brassinosteroids [*jib-uh-REL-in*]
- Y) Auxin and gibberellin
- Z) Abscisic acid and ethylene

ANSWER: W) ETHYLENE AND AUXIN

BONUS

2. BIOLOGY *Short Answer* The dental formula for the coyote is $3142/3143$ [**3 – 1 – 4 – 2 over 3 – 1 – 4 – 3**]. How many molars does it have on one side of its upper jaw?

ANSWER: 2

TOSS UP

3. ENERGY *Multiple Choice* After refining a barrel of oil, which of the following fuel fractions constitutes the largest share?

- W) Gasoline
- X) Diesel
- Y) Butane
- Z) Jet fuel

ANSWER: W) GASOLINE

BONUS

3. ENERGY *Short Answer* Efficiency of concentrated solar power systems at certain concentrations of light are a function of thermal radiation properties and what other factor?

ANSWER: CARNOT'S PRINCIPLE (ACCEPT: CARNOT'S LIMITATIONS, CARNOT'S THEOREM, CARNOT'S RULE, OR 2ND LAW OF THERMODYNAMICS)

TOSS UP

4. EARTH AND SPACE *Multiple Choice* Which of the following is a type of lake in which the bottom stratum of the water column never mixes with the strata above?

- W) Amictic
- X) Monomictic
- Y) Oligomictic
- Z) Meromictic

ANSWER: Z) MEROMICTIC

BONUS

4. EARTH AND SPACE *Short Answer* What are the three major strata of a thermally stratified lake?

ANSWER: EPILIMNION, METALIMNION, AND HYPOLIMNION

TOSS UP

5. PHYSICS *Multiple Choice* According to Heisenberg's uncertainty principle, it is impossible to simultaneously measure which of the following in a particle with arbitrary precision?

- W) Position and mass
- X) Position and linear momentum
- Y) Linear momentum and energy
- Z) Position and electric charge

ANSWER: X) POSITION AND LINEAR MOMENTUM

BONUS

5. PHYSICS *Short Answer* A simple harmonic oscillator has an amplitude of 2 centimeters. Find the value of the displacement x , in centimeters to the nearest tenth, where the kinetic potential energy of the oscillator is equal to its potential energy.

ANSWER: 1.4

TOSS UP

6. MATH *Multiple Choice* A long-play record rotates at $33\frac{1}{3}$ revolutions per minute. Which of the following represents this in radians per minute?

- W) $66\frac{2}{3}\pi$
- X) $33\frac{1}{3}\pi$
- Y) $16\frac{2}{3}$
- Z) 6π

ANSWER: W) $66\frac{2}{3}\pi$

BONUS

6. MATH *Short Answer* Find the values of a and b so that the given function $f(x)$ is continuous everywhere: $f(x)$ is a three part function: For x less than or equal to 1, $f(x) = x + 3$, for x between 1 and 4, $f(x) = ax + b$; and for x greater than or equal to 4, $f(x) = 2x - 10$.

ANSWER: $a = -2, b = 6$

TOSS UP

7. CHEMISTRY *Multiple Choice* Which of the following is NOT true with respect to balanced redox reactions?

- W) All species in the balanced equation must have the same physical state
- X) The oxidized atoms increase their oxidation number
- Y) The reduced atoms decrease their oxidation number
- Z) The total number of electrons transferred do not appear in the final, balanced reaction

ANSWER: W) ALL SPECIES IN THE BALANCED EQUATION MUST HAVE THE SAME PHYSICAL STATE

BONUS

7. CHEMISTRY *Short Answer* According to electronic transition rules, to what sublevels can an electron move from the 3s sublevel in a single step transition?

ANSWER: 4P, 4D, 4F, 2P (DO NOT ACCEPT: 4S AND 2S)

TOSS UP

8. BIOLOGY *Multiple Choice* While digging in the Jurassic-Cretaceous transitional beds in western Colorado, you uncover the fossilized bones of an animal that had a small head, spatulate teeth, a long neck and rather short feet. These bones most likely belonged to which of the following dinosaurs?

- W) Theropod
- X) Ceratopsian [*ser-uh-TOP-see-uhn*]
- Y) Ornithopod
- Z) Sauropod

ANSWER: Z) SAUROPOD

BONUS

8. BIOLOGY *Short Answer* In 2001, the Nobel Prize was awarded to three scientists for their discoveries of two groups of key protein regulators of the cell cycle. The first group consists of the CDKs, which remain at fairly constant concentration throughout the cell cycle. What is the name of the second group, which interacts with CDKs to control their activity and varies in concentration over the cell cycle?

ANSWER: CYCLINS

TOSS UP

9. ENERGY *Short Answer* How much power in watts is consumed by a device with a resistance of 15 ohms at a current of 3 amperes?

ANSWER: 135

BONUS

9. ENERGY *Multiple Choice* Which of the following greenhouse gases stays the longest in the atmosphere?

- W) Nitrous oxide
- X) Carbon dioxide
- Y) Sulfur hexafluoride
- Z) Methane

ANSWER: Y) SULFUR HEXAFLUORIDE

TOSS UP

10. EARTH AND SPACE *Multiple Choice* Which of the following is the name of the law that quantitatively describes one-dimensional water flow in saturated soils?

- W) Ohm's
- X) Fick's
- Y) Fourier's
- Z) Darcy's

ANSWER: Z) DARCY'S

BONUS

10. EARTH AND SPACE *Multiple Choice* Why are Type 1a supernovae [*soo-per-NOH-vee*] thought to have different progenitors from other kinds of supernovae?

- W) They have very different light curves from other supernovae
- X) They are 100 times more luminous than all other kinds of supernovae
- Y) The lack of hydrogen lines in their spectra means that the progenitor must have lost its envelope
- Z) They are seen in all galaxies, whereas other kinds of supernovae are only seen in star-forming regions of spiral galaxies

ANSWER: Z) THEY ARE SEEN IN ALL GALAXIES, WHEREAS OTHER KINDS OF SUPERNOVAE ARE ONLY SEEN IN STAR FORMING REGIONS OF SPIRAL GALAXIES

TOSS UP

11. PHYSICS *Multiple Choice* When a light ray enters into a medium with a higher index of refraction, which of the following is true?

- W) Its speed increases but its wavelength decreases
- X) Its speed decreases but its wavelength increases
- Y) Both speed and wavelength increase
- Z) Both speed and wavelength decrease

ANSWER: Z) BOTH SPEED AND WAVELENGTH DECREASE

BONUS

11. PHYSICS *Short Answer* Providing your answer in scientific notation with two significant figures, what is the wavelength, in meters, of a 50 mega-electron volt photon, given 6.6×10^{-34} joule seconds as Planck's constant and 1.6×10^{-19} coulombs as the elementary charge?

ANSWER: 2.5×10^{-14}

TOSS UP

12. MATH *Short Answer* Suppose that $\theta = \sin^{-1}\left(\frac{3}{5}\right)$ [*theta equals the inverse sine of three fifths*]. Find the exact value of $\tan \theta$ [*tangent of theta*].

ANSWER: $\frac{3}{4}$

BONUS

12. MATH *Short Answer* Find $\frac{dy}{dx}$ at the point with coordinates (1, 2) if y is implicitly defined by the equation $x^3y + xy^2 = 6$.

ANSWER: -2

TOSS UP

13. CHEMISTRY *Multiple Choice* Which of the following is NOT characteristic of amines?

- W) A fully protonated amine is called an ammonium ion
- X) Amines can function as Brønsted bases
- Y) The VSEPR geometry of the nitrogen atom is trigonal planar
- Z) Amines can be a hydrogen bond acceptor

ANSWER: Y) THE VSEPR GEOMETRY OF THE NITROGEN ATOM IS TRIGONAL PLANAR

BONUS

13. CHEMISTRY *Multiple Choice* Which of the following elements seemingly violates Hund's rule by shifting an electron from a full s orbital to another sublevel to give a more stable configuration?

- W) Chromium
- X) Tungsten
- Y) Boron
- Z) Cerium

ANSWER: W) CHROMIUM

TOSS UP

14. BIOLOGY *Multiple Choice* Which of the following animals does NOT belong in the superorder Afrotheria?

- W) Hyrax
- X) Dugong
- Y) Hoopoe [**HOO-poo**]
- Z) Elephant

ANSWER: Y) HOOPOE

BONUS

14. BIOLOGY *Multiple Choice* Which of the following is NOT a regulatory characteristic of transcriptionally-active regions of a chromosome?

- W) They are not very condensed
- X) They are hypersensitive to DNase I [**D-N-ase one**]
- Y) They possess leucine [**LOO-seen**] zipper domains
- Z) They are undermethylated

ANSWER: Y) THEY POSSESS LEUCINE ZIPPER DOMAINS

TOSS UP

15. EARTH AND SPACE *Short Answer* Arrange the following four surfaces in order of highest to lowest albedo: 1) fresh snow, 2) old snow, 3) water at a small zenith angle, 4) short grass.

ANSWER: 1, 2, 3, 4 (ACCEPT: FRESH SNOW, OLD SNOW, WATER AT A SMALL ZENITH ANGLE, SHORT GRASS)

BONUS

15. EARTH AND SPACE *Short Answer* What is the name for the apparent annual displacement of stars due to the finite speed of light?

ANSWER: ABERRATION OF LIGHT

TOSS UP

16. PHYSICS *Multiple Choice* Which of the following is true about the rest mass of a photon?

- W) It is always zero
- X) It depends on its wavelength
- Y) It depends on the speed of the inertial observer
- Z) It depends on the medium in which it moves

ANSWER: W) IT IS ALWAYS ZERO

BONUS

16. PHYSICS *Multiple Choice* An electron is moving at a speed of 1.5×10^7 meters per second. Which of the following is its de Broglie wavelength in meters, given that the mass of the electron is 9.1×10^{-31} kilograms and that the Planck constant h is 6.63×10^{-34} joule seconds?

- W) 5×10^{-11}
- X) 5×10^{-12}
- Y) 2×10^{11}
- Z) 2×10^{12}

ANSWER: W) 5×10^{-11}

TOSS UP

17. MATH *Short Answer* Find the exact value of the expression: $\frac{\sin(\frac{5\pi}{4})}{\cos(\frac{5\pi}{4})}$ **[the fraction with numerator, sine of, 5 pi over 4, and denominator, cosine of, 5 pi over 4].**

ANSWER: 1

BONUS

17. MATH *Short Answer* Two objects move along a number line. At t seconds, their positions are given as $s_1 = 2t - t^2$ and $s_2 = 2t^2 - 3t$. Providing your answers as fractions in simplest form, give all times in seconds when the two objects have the same speed.

ANSWER: $\frac{5}{6}$ AND $\frac{1}{2}$

TOSS UP

18. CHEMISTRY *Multiple Choice* In a first order reaction in which a graph is made showing concentration versus time, the shape of the graph is best described as which of the following?

- W) Linear
- X) Exponential
- Y) Logarithmic
- Z) Hyperbolic

ANSWER: X) EXPONENTIAL

BONUS

18. CHEMISTRY *Short Answer* What Nobel Prize-winning named reaction allows for the single-step formation of cyclohexene from butadiene and ethene?

ANSWER: DIELS-ALDER

TOSS UP

19. BIOLOGY *Multiple Choice* Symbiotic dinoflagellates [*din-uh-FLAJ-uh-layts*] found in hermatypic corals are known as which of the following?

- W) Radiolarians [*ray-dee-oh-lair-ee-uhns*]
- X) Copepods
- Y) Zooxanthellae [*zoh-uh-zan-THEL-ee*]
- Z) Coccoliths [*KOK-uh-liths*]

ANSWER: Y) ZOOXANTHELLAE

BONUS

19. BIOLOGY *Multiple Choice* Compared to a lecithotrophic [*le-si-thuh-TROH-fik*] benthic invertebrate larva, a planktotrophic benthic invertebrate larva does which of the following?

- W) Spends more time in the egg stage
- X) Tends to be a larger size when it hatches
- Y) Is less dependent on yolk reserves
- Z) Spends less time in the water column before settling

ANSWER: Y) IS LESS DEPENDENT ON YOLK RESERVES

TOSS UP

20. ENERGY *Multiple Choice* Which of the following countries holds the largest proven natural gas reserves in the entire world?

- W) Russia
- X) Iran
- Y) Saudi Arabia
- Z) USA

ANSWER: W) RUSSIA

BONUS

20. ENERGY *Multiple Choice* In which of the following is aluminum oxide dissolved when using the Hall-Heroult process to produce aluminum?

- W) Molten cryolite
- X) Hydrogen peroxide
- Y) Sodium chloride
- Z) Water

ANSWER: W) MOLTEN CRYOLITE

TOSS UP

21. EARTH AND SPACE *Multiple Choice* In which of the following environments would you most likely find an alluvial [*uh-LOO-vee-uhl*] fan?

- W) Mouth of the Mississippi in the Gulf of Mexico
- X) Outwash plain of a newly receding glacier in Alaska
- Y) Base of a submarine canyon off of the continental shelf of the Western Atlantic
- Z) Along the lowermost edge of a slump in a densely vegetated region

ANSWER: X) OUTWASH PLAIN OF A NEWLY RECEDING GLACIER IN ALASKA

BONUS

21. EARTH AND SPACE *Multiple Choice* How were the rings of Uranus first discovered?

- W) Voyager 2 flyby
- X) Occultations of a background star
- Y) Hubble Space Telescope observations
- Z) Radar

ANSWER: X) OCCULTATIONS OF A BACKGROUND STAR

TOSS UP

22. PHYSICS *Multiple Choice* Which of the following is equal to one tesla?

- W) 100 newtons per ampere meter
- X) 10 newtons per ampere meter
- Y) 10 millinewtons per ampere centimeter
- Z) 10 kilograms per ampere second squared

ANSWER: Y) 10 MILLINEWTONS PER AMPERE CENTIMETER

BONUS

22. PHYSICS *Multiple Choice* A puck is nudged due south on a flat, level and frictionless table at a latitude of 30° north. If the puck's initial speed is 3 millimeters per second, how many millimeters west has it gone after traveling 0.6 meters south?

- W) 0.1
- X) 4
- Y) 40
- Z) 110

ANSWER: X) 4

TOSS UP

23. MATH *Multiple Choice* Which of the following values represents the slope of the tangent line at $x = 0$ to the curve $y = e^{-x}$ [**y equals e to the negative x**]?

- W) $-e$
- X) -1
- Y) 0
- Z) 1

ANSWER: X) -1

BONUS

23. MATH *Short Answer* A spherical balloon initially contains no air and is inflated in such a way that its radius increases at a rate of 2 centimeters per second. Providing your answer in terms of pi, how fast is the volume increasing in cubic centimeters per second 3 seconds after inflation starts?

ANSWER: 288π

TOSS UP

24. CHEMISTRY *Short Answer* Calculate the first order half-life in seconds to one significant figure if the rate constant is 1.7×10^{-3} inverse seconds.

ANSWER: 400

BONUS

24. CHEMISTRY *Short Answer* While eating fish, you feel that the fish needs a little vinegar. Unfortunately, you add way too much. To lower the acidity of the fish again, you decide to add packets containing 3 moles each of sodium acetate. You estimate that you have added 1 mole of vinegar to your fish based on the fact that it has a pH around 2. Given that the pKa of acetic acid is 4.74, to the nearest whole packet, how many packets of sodium acetate must you add to the fish in order to bring the pH up to around 5.5?

ANSWER: 2

TOSS UP

25. BIOLOGY *Multiple Choice* In which of the following locations does human blood have the highest oxygen concentration?

- W) Pulmonary artery
- X) Pulmonary vein
- Y) Right atrium
- Z) Capillaries in fingers

ANSWER: X) PULMONARY VEIN

BONUS

25. BIOLOGY *Multiple Choice* In sickle cell anemia, which of the following is the specific mutation in the beta-globin gene that causes the disease?

- W) Alanine-6 mutated to arginine [**AHR-juh-neen**]
- X) Glutamate-6 mutated to valine
- Y) Leucine-6 [**LOO-seen**] mutated to lysine
- Z) Arginine-6 mutated to glycine

ANSWER: X) GLUTAMATE-6 MUTATED TO VALINE