

DOUBLE ELIMINATION 3

TOSS-UP

- 1) Longtermism - *Short Answer* What is the most virulent disease caused by a filovirus [FYE-luh-virus]?

ANSWER: Ebola virus disease

BONUS

- 1) Longtermism - *Multiple Choice* Which factor regarding the spread of viruses did NOT present an obstacle to containing the 2014 Ebola virus disease outbreak?

- W) Located in West Africa, rather than equatorial Africa
- X) Located in large cities, rather than rural villages
- Y) Spread amongst migrant workers, rather than native-born workers
- Z) Spread across porous borders, rather than secured borders

ANSWER: Y) Spread amongst migrant workers, rather than native-born workers

TOSS-UP

2) Math - *Short Answer* To two significant figures and in radians, compute $\text{arcsec } 10000$ [arc secant of ten thousand].

ANSWER: 1.6

BONUS

2) Math - *Short Answer* A square with side length 1 lies with a flat side on a plane. It is rolled along the plane without slipping until it makes one full rotation. What is the area of the shape made by tracing out the path of vertex originally in the square's lower left corner?

ANSWER: $\pi + 1$

TOSS-UP

3) Chemistry - *Short Answer* 12-crown-4, 15-crown-5, and 18-crown-6 are cyclic oligomers [uh-LIH-guh-mers] of what 2 carbon organic compound?

ANSWER: Ethylene [ETH-ih-leen] oxide (ACCEPT: Oxirane)

BONUS

3) Chemistry - *Short Answer* Identify all of the following three molecules that can be studied via EPR spectroscopy: 1) Nitric oxide; 2) Oxygen gas; 3) Titanium dioxide.

ANSWER: 1 and 2

TOSS-UP

4) Earth and Space - *Multiple Choice* A sand dune forms in a semiarid coastal region where moisture anchors it to the ground. What type of dune is this most likely to be?

- W) Barchan [BAR-ken]
- X) Transverse
- Y) Parabolic
- Z) Star

ANSWER: Y) Parabolic

BONUS

4) Earth and Space - *Multiple Choice* Which of the following conditions would create the most positive gravity anomaly?

- W) Deep oceanic trench
- X) Subsurface mantle plume
- Y) Strong monsoon season
- Z) Thick ice sheet cover

ANSWER: Z) Thick ice sheet cover

TOSS-UP

5) Biology - *Short Answer* Immune exclusion describes the phenomenon where immunoglobulins block the translocation of bacteria across the gut epithelium [EH-pih-THEE-lee-um] and promote their clearance from the gut lumen. This is mediated by the secretory form of what class of immunoglobulin, which is also the most common immunoglobulin in the gut?

ANSWER: IgA

BONUS

5) Biology - *Multiple Choice* Which of the following statements is not true about hormonal and neural control of digestion?

- W) Secretin [suh-KREE-tin] inhibits the release of gastrin from G cells
- X) Acetylcholine [uh-SEE-dul-KO-leen] activates H+/K+ ATPases on parietal [puh-RYE-ih-dul] cells
- Y) Cholecystokinin [KOL-uh-SIS-tuh-KYE-nin] triggers contraction of the gall-bladder
- Z) Secretin binds to Acinar [A-sih-nar] cells in the pancreas to trigger release of bicarbonate ions

ANSWER: Z) Secretin binds to Acinar cells in the pancreas to trigger release of bicarbonate ions

TOSS-UP

- 6) Physics - *Short Answer* Planet A has triple the mass of planet B and both orbit around their common center of mass. Identify all of the following that are true of this system: 1) The reduced mass of the system is $2/3$ of the mass of planet B; 2) Both planets have the same angular momentum; 3) Both planets have the same energy in orbit.

ANSWER: None

BONUS

- 6) Physics - *Short Answer* The wavefunctions of bosons have what special property that maximizes degeneracy in the lowest energy state?

ANSWER: Symmetry

TOSS-UP

7) Longtermism - *Short Answer* Some Cold-War era aircraft used vacuum tube avionics [ay-vee-AW-niks] to increase resilience to what specific effect of nuclear weapons?

ANSWER: Nuclear electromagnetic pulse (ACCEPT: electromagnetic pulse, EMP)

BONUS

7) Longtermism - *Short Answer* The effect of a nuclear electromagnetic pulse would be similar to the effect of which large-scale solar phenomenon?

ANSWER: Coronal mass ejection

TOSS-UP

8) Math - *Multiple Choice* Given the following two statements: $p \implies q$ [if p, then q] and $q \implies r$ [if q, then r], then what law allows for the conclusion $p \implies r$ [if p, then r]?

- W) Contrapositive
- X) Detachment
- Y) Syllogism [SIH-luh-jism]
- Z) De Morgan's

ANSWER: Y) Syllogism

BONUS

8) Math - *Multiple Choice* An inverted cone with base radius 18 cm and height 30 cm is full of water. The water is poured into a tall cylinder whose horizontal base has radius of 36 cm. What is the height in centimeters of the water in the cylinder?

- W) 1.5
- X) 2
- Y) 2.5
- Z) 3

ANSWER: Y) 2.5

TOSS-UP

9) Chemistry - *Short Answer* The isocyanate [EYE-suh-SIGH-uh-nate] anion is isoelectronic to what nitrogen oxide?

ANSWER: Nitrous oxide (ACCEPT: N₂O)

BONUS

9) Chemistry - *Multiple Choice* Which of the following allotropes of phosphorus has the most negative enthalpy of formation?

- W) White phosphorus
- X) Red phosphorus
- Y) Violet phosphorus
- Z) Black phosphorus

ANSWER: Z) Black phosphorus

TOSS-UP

10) Earth and Space - *Short Answer* Identify all of the following three stellar populations that contain classical Wolf-Rayet [RAY-et] stars: 1) Population I; 2) Population II; 3) Population III.

ANSWER: 1 only

BONUS

10) Earth and Space - *Multiple Choice* Which of the following could not be used to distinguish galactic spiral arms from the rest of the galaxy?

- W) OB associations
- X) Emission nebulae
- Y) Globular clusters
- Z) Young open clusters

ANSWER: Y) Globular Clusters

TOSS-UP

11) Biology - *Short Answer* Identify all of the following three sugars which contain 4-carbon atoms: 1) Erythrose [AIR-ih-throse]; 2) Threose [THREE-ose]; 3) Arabinose [uh-RA-bih-nohse].

ANSWER: 1 and 2

BONUS

11) Biology - *Short Answer* What chromosomal abnormality is present in the majority of patients with chronic myelogenous [MY-uh-LOW-jeh-nus] leukemia, and results from the fusion of the BCR and ABL genes?

ANSWER: Philadelphia Chromosome

TOSS-UP

12) Physics - *Short Answer* The Debye model built the concept of what quasi-particle's effect on solid heat capacity rather than using the quantum harmonic oscillator estimation?

ANSWER: Phonon

BONUS

12) Physics - *Short Answer* An electron gas is cooled to absolute zero. The electrons will occupy all the energy states up until what threshold?

ANSWER: Fermi energy (ACCEPT: Fermi level)

TOSS-UP

13) Longtermism - *Multiple Choice* Many people may delay having children to give them a better life and more financial security. However, this decision leads different children to come into existence, which means that different people are benefitted or harmed in this situation. What is this an example of?

- W) The utility monster
- X) The repugnant conclusion
- Y) The future moral status problem
- Z) The nonidentity problem

ANSWER: Z) The nonidentity problem

BONUS

13) Longtermism - *Short Answer* Some solutions to the nonidentity problem suggest that all acts of procreation are harmful. What is this philosophical position called?

ANSWER: Antinatalism

TOSS-UP

14) Math - *Multiple Choice* The number of holes in a topological surface is called the:

- W) Degree
- X) Toral index
- Y) Genus
- Z) Torus number

ANSWER: Y) Genus

BONUS

14) Math - *Short Answer* A small sudoku is played where a 3 by 3 array is filled in with all columns and rows including a 1, 2, and 3. How many possible arrays satisfying these rules are possible?

ANSWER: 12

TOSS-UP

15) Chemistry - *Multiple Choice* Which of the following molecules does not contain an inversion center?

- W) Allene [AL-een]
- X) Xenon tetrafluoride
- Y) Acetylene [uh-SEE-duh-leen]
- Z) Ferricyanide [FAIR-ih-SIGH-uh-nide]

ANSWER: W) Allene

BONUS

15) Chemistry - *Short Answer* What is the name of the organic compound formed when 2-butene is treated with ozone, followed by triphenylphosphine [tri-FEE-null-FOSS-feen]?

ANSWER: Acetaldehyde [A-sih-TAL-duh-hide] (ACCEPT: Ethanal)

TOSS-UP

16) Earth and Space - *Short Answer* What group of porous minerals is currently being studied because it should have millions of possible structures, but only a few hundred have been observed or synthesized?

ANSWER: Zeolites [ZEE-uh-lites]

BONUS

16) Earth and Space - *Multiple Choice* The presence of layers with alternating directions of cross-bedding typically indicates formation in which of the following depositional environments?

- W) Aeolian
- X) Fluvial
- Y) Lacustrine [luh-KOOS-treene]
- Z) Tidal

ANSWER: Z) Tidal

TOSS-UP

17) Biology - *Multiple Choice* The JAK-STAT signaling pathway has come under recent interest due to its potential involvement in autoimmune diseases. Which of the following best describes the identity of JAK proteins?

- W) G proteins
- X) Serine/threonine [SAIR-een THREE-uh-neen] kinases
- Y) Tyrosine [TY-ruh-seen] kinases
- Z) Phosphoinositide [FOSS-fo-ih-NAW-sih-tide] 3-kinases

ANSWER: Y) Tyrosine kinases

BONUS

17) Biology - *Short Answer* What is the term given to a fruit that develops without fertilization, and includes many commercial seedless fruits?

ANSWER: Parthenocarpic [par-THEH-nuh-KAR-pik]

TOSS-UP

18) Physics - *Multiple Choice* Which of the following particles couples most strongly to photons via the electromagnetic force?

- W) Neutrino
- X) Bottom quark
- Y) Top quark
- Z) Strange quark

ANSWER: Y) Top quark

BONUS

18) Physics - *Short Answer* According to the Ising model, a crystal can have net zero magnetization due to electron spins aligning opposite to that of their neighbors over long range at low temperature. What is the name given to the threshold temperature above which this phenomenon disappears?

ANSWER: Néel [NEEL] temperature

TOSS-UP

19) Longtermism - *Short Answer* Alan Turing's concept of a learning machine led to what type of optimization algorithm that includes a systematic representation of solutions, a means of modifying solutions, and an objective function for evaluating solutions?

ANSWER: Genetic algorithm

BONUS

19) Longtermism - *Multiple Choice* Which of the following features is NOT a major detraction of genetic algorithms?

- W) Ignoring global optima in favor of local optima
- X) Computationally intensive fitness function
- Y) Exponentially increasing runtime for more mutated elements
- Z) Difficulty in being parallelized

ANSWER: Z) Difficulty in being parallelized

TOSS-UP

20) Math - *Short Answer* By name or number, identify all of the following three properties that classify the function $f(x) = \sin(x)$ for all real numbers: 1) Bijective; 2) Injective; 3) Surjective.

ANSWER: None

BONUS

20) Math - *Short Answer* The number 1,000,001 is called quadly because it only has four factors. What is the second smallest of those factors?

ANSWER: 101

TOSS-UP

21) Chemistry - *Multiple Choice* What method describes the separation of a biomolecule from a mixture by utilizing the highly specific macromolecular binding interaction between the biomolecule and the ligand?

- W) Ion exchange chromatography
- X) Hydrophobic interaction chromatography
- Y) Gel filtration chromatography
- Z) Affinity chromatography

ANSWER: Z) Affinity chromatography

BONUS

21) Chemistry - *Short Answer* Identify all of the following three molecules that contain a chiral [KY-ral] center: 1) Ferric oxalate; 2) 2-butene; 3) 2-butanol.

ANSWER: 1 and 3

TOSS-UP

22) Earth and Space - *Multiple Choice* Because massive protostars are not driven by nuclear fusion, their luminosity most directly depends on which of the following properties?

- W) Age
- X) Composition
- Y) Mass
- Z) Temperature

ANSWER: Y) Mass

BONUS

22) Earth and Space - *Short Answer* Order the following three star populations in order of increasing average mass: 1) Population I; 2) Population II; 3) Population III.

ANSWER: 2, 1, 3

TOSS-UP

23) Biology - *Short Answer* Because it is inherited uniparentally and can't shed mutations by recombination, the mitochondrial genome is expected to accumulate deleterious mutations through what mechanism?

ANSWER: Muller's ratchet

BONUS

23) Biology - *Short Answer* Identify all of the following three statements that are true about cell junctions: 1) Adherens [uh-dih-HERE-uhns] junctions connect to actin filaments; 2) Connexins form invertebrate gap junctions; 3) Desmins are found in epithelial [eh-pih-THEE-lee-ul] cells.

ANSWER: 1 only

TOSS-UP

24) Physics - *Multiple Choice* At which point during a satellite's orbit should its engines fire to maximize the final velocity?

- W) Perigee [PARE-ih-jee]
- X) Apogee
- Y) Covertex
- Z) Focus

ANSWER: W) Perigee

BONUS

24) Physics - *Short Answer* In terms of the ideal gas constant R, what is the entropy of mixing three separate, identical samples of 1 mole of an ideal gas at constant pressure?

ANSWER: $3R\ln 3$