Standard Division Double Elimination 6

TOSS-UP

1) BIOLOGY *Multiple Choice* Which of the following best describes the hypersensitive response in plant immunity?

W) Local production of antimicrobial chemicals and hardening of cell walls

X) Localized cell death around the area of infection

Y) Upregulation of defensive hormones such as jasmonic acid

Z) Production of salicylic **[*SA-lih-SIH-lick*]** acid triggering global antimicrobial defenses

ANSWER: X) LOCALIZED CELL DEATH AROUND THE AREA OF INFECTION [GKD]

BONUS

1) BIOLOGY *Short Answer* Uncoupling the proton gradient from ATP synthesis during oxidative phosphorylation by allowing protons to freely flow down their concentration gradient is characteristic of what mode of heat production?

ANSWER: NONSHIVERING THERMOGENESIS [GKD]

TOSS-UP

2) CHEMISTRY *Short Answer* Chelating **[*cheh-LAY-ting*]** agents, such as EDTA, form multiple covalent bonds with a central metal atom by forming a ring of atoms including the metal center. Because of this, they are given a value greater than one of what measure of how many atoms a ligand binds to a metal ion with?

ANSWER: DENTICITY [GKD]

BONUS

2) CHEMISTRY *Short Answer* In terms of its translational kinetic energy K, what is the pressure exerted by an ideal gas?

ANSWER: 2K/3 [GKD]

TOSS-UP

3) EARTH AND SPACE *Short Answer* What is the equilibrium vapor pressure, in kilopascals, of water in an air parcel at 16% relative humidity if the current partial pressure is 480 Pascals?

ANSWER: 3 (DO NOT ACCEPT: 3000) [EB]

BONUS

3) EARTH AND SPACE *Short Answer* When water freezes and expands in rocks, small, often gravel-sized fragments break off, forming piles at the angle of repose located along the bases of mountains and cliff faces. What is the name for these deposits?

ANSWER: TALUS **[*TAY-lus*]** (ACCEPT: SCREE) [EB]

TOSS-UP

4) MATH *Short Answer* How many distinct bracelets can be made out of 7 distinct beads, given that bracelets are distinct if they are not a reflection or rotation of each other and each bracelet must use all 7 beads?

ANSWER: 360 [MD]

BONUS

4) MATH *Short Answer* In triangle ABC, AB has length 6, BC has length 4, and angle A is 30 degrees. What is the product of all possible lengths of AC?

ANSWER: 20 [AKa]

TOSS-UP

5) PHYSICS *Short Answer* A 2d object in the xy-plane is spun around the x and y axes. Its average moment of inertia for these two axes is 22.5 kilogram meters squared, and the moment of inertia about the x-axis is 7/12 that about the y-axis. What is the moment of inertia of this object about the z-axis, in kilogram meters squared?

ANSWER: 45 [AC]

BONUS

5) PHYSICS *Multiple Choice* Akshansh hangs on to a merry-go-round using a friction force proportional to the centrifugal force. Initially he is at rest in the frame of the merry-go-round, but when given a nudge by Alexander, he slides outward radially. Which of the following best explains what happens to Akshansh?

W) He remains on the merry-go-round

X) He continues to slide outward at a constant acceleration

Y) He continues to slide outward at an increasing acceleration

Z) He returns to his original position

ANSWER: W) HE REMAINS ON THE MERRY-GO-ROUND [AC]

TOSS-UP

6) ENERGY *Short Answer* Davidson HS A Team members are studying sound in solids. When they use quantum mechanics to describe the oscillation of atoms in a solid, they find what quasiparticle to be the quantized unit of sound?

ANSWER: PHONON [AC]

BONUS

6) ENERGY *Multiple Choice* Davidson MS A team members are studying trigonometric identities. Which of the following expressions is equal to sine of B plus cosine of B?

W) Negative sine of quantity pi minus B end quantity plus cosine B

X) Sine of quantity pi minus B end quantity plus cosine of B

Y) Sine of B plus sine of quantity B minus pi halves end quantity

Z) Sine of B minus sine of quantity B plus pi halves end quantity

ANSWER: X) SINE OF QUANTITY PI MINUS B END QUANTITY PLUS COSINE OF B [EB]

TOSS-UP

7) BIOLOGY *Multiple Choice* Though it may seem counterintuitive, the intentional killing of young offspring by an older member of the same species, termed infanticide, is a strategy employed by many different species. Typically, males will kill the offspring of other males as a form of sexual selection. Which of the following is not a potential reason that infanticide may be beneficial for the killers?

W) Increased parental investment for their young

X) Increased contribution to the gene pool

Y) Increased fertility of females due to ceasing lactation

Z) Reduced interspecific competition

ANSWER: Z) REDUCED INTERSPECIFIC COMPETITION [GKD]

BONUS

7) BIOLOGY *Short Answer* Identify all of the following three statements that are true about intracellular transport:

1) Myosin is associated with microfilaments
2) Vesicles containing neurotransmitters to be exocytosed would be transported to the cell periphery by dynein **[*DIE-nee-in*]**
3) During mitosis, chromosomes are moved to the metaphase plate as intermediate filaments attach to their kinetochores

ANSWER: 1 ONLY (ACCEPT: MYOSIN IS ASSOCIATED WITH MICROFILAMENTS) [GKD]

TOSS-UP

8) CHEMISTRY *Short Answer* Identify all of the following three molecules that are considered conjugated π systems:

1) 1,3-butadiene
2) Benzene
3) Propene

ANSWER: ALL [GKD

BONUS

8) CHEMISTRY *Short Answer* In quantum chemistry, the rigid rotor is a mathematical model for approximating the rotations of a molecule. The simplest rigid rotor holds two atoms at a constant distance from each other and allows them to spin. How many quantum numbers would you need to describe this system?

ANSWER: 2 [GKD]

TOSS-UP

9) EARTH AND SPACE *Short Answer* The sun has an apparent magnitude of approximately -27. Approximating the moon's apparent magnitude as -12, how many times brighter than the moon is the sun?

W) 100

X) 10,000

Y) 1,000,000

Z) 100,000,000

ANSWER: Y) 1,000,000 [EB]

BONUS

9) EARTH AND SPACE *Multiple Choice* Jonathan is observing a star and notices that it appears to wobble, as if it were orbiting some external center of mass. He determines that this star must have a fainter binary companion. What type of binary system is Jonathan's find an example of?

W) Spectroscopic binary

X) Eclipsing binary

Y) Astrometric binary

Z) Spectrum binary

ANSWER: Y) ASTROMETRIC BINARY [EB]

TOSS-UP

10) MATH *Short Answer* What is the leftmost digit of the base 10 number 923 when expressed in base 6?

ANSWER: 4 [MD]

BONUS

10) MATH *Short Answer* What is the distance between the focus and directrix of a parabola with equation x equals negative three y squared plus y?

ANSWER: 1/6 [AKa]

TOSS-UP

11) PHYSICS *Short Answer* A thin spherical shell is constructed out of a charged insulator. If the potential just inside the shell, near the surface of the insulator is 50 volts, what is the potential at the center of the shell, in volts?

ANSWER: 50 [AC]

BONUS

11) PHYSICS *Short Answer* Milliken attempts to perform his famous oil drop experiment and determine the charge of the electron. He uses a parallel plate capacitor to produce an electric field. However, his numbskull assistant, Akshansh, places the plates 3 times closer than Milliken told him to and applies 50% more voltage. What erroneous value, to two significant figures and in Coulombs, will Millikan obtain for the charge of the electron, assuming he does not realize the error?

ANSWER: $7.2 * 10^{-19}$ [AC]

TOSS-UP

12) ENERGY *Short Answer* Davidson MS A team members are currently studying isomerism. When two isomers differ by the location of a pi bond and a proton, such as a ketone and an enol, they can readily interconvert. What is this form of isomerism called?

ANSWER: TAUTOMERISM [GKD]

BONUS

12) ENERGY *Short Answer* Davidson HS A Team members are studying ophiolite **[*oh-FYE-oh-lite*]** complexes. What mafic igneous rock, often forming the sheeted dikes found in ophiolites, has the same composition as gabbro but has an intermediate-grained texture?

ANSWER: DIABASE (ACCEPT: DOLERITE) [EB]

TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following statements is not true about the digestion and absorption of fat?

W) Fats are primarily digested in the small intestine

X) To be absorbed, monoglycerides and fatty acids are emulsified with bile

Y) Chylomicrons **[*kye-low-MY-crons*]** consist of triglycerides, phospholipids, and associated proteins

Z) After being formed, chylomicrons are transported initially by the hepatic portal vein

ANSWER: Z) AFTER BEING FORMED, CHYLOMICRONS ARE TRANSPORTED INITIALLY BY THE HEPATIC PORTAL VEIN [GKD]

BONUS

13) BIOLOGY *Short Answer* Identify all of the following three mutations that would block all transcription of the *lac* **[*LACK*]** operon:

1) Mutation in the DNA-binding portion of the repressor
2) Mutation in the CAP binding site of the promoter
3) Mutation in the allosteric site of the repressor that prevents allolactose binding

ANSWER: 3 ONLY [GKD]

TOSS-UP

14) CHEMISTRY *Short Answer* When performing a chemical synthesis, Derek notices that one step is stereospecific. Identify all of the following three reaction mechanisms that this step most likely does not follow:

1) S_N1
2) S_N2
3) E1

ANSWER: 1 AND 3 [GKD]

BONUS

14) CHEMISTRY *Short Answer* Identify all of the following three factors that would increase the acidity of phenol, a hydroxyl group attached to a benzene ring:

1) Replacing the oxygen with a sulfur atom
2) Replacing the benzene ring with cyclohexane
3) Replacing the hydrogen atom at the *para* position with a fluorine atom

ANSWER: 1 AND 3 [GKD]

TOSS-UP

15) EARTH AND SPACE *Multiple Choice* Which of the following is an irregular ridge of desert rock that is formed when wind erosion carries less resistant material away?

W) Blowout

X) Yardang

Y) Bolson

Z) Monadnock **[*MAH-nad-nock*]**

ANSWER: X) YARDANG [EB]

BONUS

15) EARTH AND SPACE *Short Answer* By name or number, identify all of the following three minerals that are phyllosilicates **[*FIE-low-silicates*]**:

1) Almandine **[*ALL-mun-deen*]**
2) Forsterite
3) Lepidolite **[*leh-PIH-doe-lite*]**

ANSWER: 3 ONLY (ACCEPT: LEPIDOLITE) [EB]

TOSS-UP

16) MATH *Short Answer* If five workers can build four houses in six weeks, then how many weeks will it take for three workers to build six houses, assuming that all workers build houses at the same constant rate?

ANSWER: 15 [AKa]

BONUS

16) MATH *Short Answer* The Great Pyramids of Egypt plus one less-great pyramid are being stacked on top of each other, with the smallest on top and the largest on bottom. All side lengths of the smallest are 100 meters, the next are all 200, then 300, and then 400 meters. What is the total exposed surface area of this masterpiece?

ANSWER: 140000 + 75000*sqrt(3) [MD]

TOSS-UP

17) PHYSICS *Multiple Choice* Which of the following best describes the difference between the inner core and the outer cladding of a fiber optic cable?

W) The cladding has a lower index of refraction

X) The cladding has a higher index of refraction

Y) The core must be a perfect mirror

Z) The cladding must be a perfect mirror

ANSWER: W) THE CLADDING HAS A LOWER INDEX OF REFRACTION [AC]

BONUS

17) PHYSICS *Short Answer* Akshansh takes a job as a test dummy and his 50 kilogram body is dropped from a height of 10 meters in Ultra-siberia, where the temperature is -173.15 degrees celsius. What is the change in entropy of the system, taking g to be 9.8 m/s and in Joules per Kelvin?

ANSWER: 49 [AC]

TOSS-UP

18) ENERGY *Multiple Choice* Davidson HS B team members are studying carbon stars. These stars are formed by convection after helium burning finishes. In which of the following regions of the HR diagram would one expect to find these stars?

W) Henyey **[*HEN-yee*]** track

X) Main sequence

Y) Asymptotic giant branch

Z) Instability strip

ANSWER: Y) ASYMPTOTIC GIANT BRANCH [EB]

BONUS

18) ENERGY *Multiple Choice* Davidson MS C team members are currently studying forest ecology. Which of the following is the best interpretation of a leaf area index of 3?

W) Every 3 m^2 of ground area is covered by 1 m^2 of leaf area

X) Every 1 m^2 of ground area is covered by 3 m^2 of leaf area

Y) 3% of ground area is covered by leaves

Z) 30% of ground area is covered by leaves

ANSWER: X) EVERY 1 M^2 OF GROUND AREA IS COVERED BY 3 M^2 OF LEAF AREA [GKD]

TOSS-UP

19) BIOLOGY *Multiple Choice* Endoreduplication is the process of DNA replication occurring without mitotic division, forming polyploid cells. It is theorized endoreduplication is used in cells that need to increase their size and protein production. Which of the following immune cells is most likely to undergo endoreduplication?

W) Megakaryocyte **[*mega-CARE-yo-site*]**

X) Neutrophil

Y) Dendritic cell

Z) Macrophage

ANSWER: W) MEGAKARYOCYTE [GKD]

BONUS

19) BIOLOGY *Short Answer* Identify all of the following three neurotransmitters that are primarily inhibitory in the central nervous system:

1) GABA
2) Glycine
3) Glutamate

ANSWER: 1 AND 2 (ACCEPT: GABA, GLYCINE) [GKD]

TOSS-UP

20) CHEMISTRY *Multiple Choice* Which d orbital has a distinct shape from the other four, having nodal cones instead of nodal planes?

W) dxy

X) dx^2-y^2

Y) dxz

Z) dz^2

ANSWER: Z) dz^2 [GKD]

BONUS

20) CHEMISTRY *Short Answer* Identify all of the following three conditions that would tend to favor an S_N2 reaction:

1) Tertiary substrate
2) Strong nucleophile
3) Polar aprotic solvent

ANSWER: 2 AND 3 [GKD]

TOSS-UP

21) EARTH AND SPACE *Short Answer* Assuming Jupiter's orbital radius as 5 AU, how long, in Earth years, does it take Jupiter to orbit the sun twice?

ANSWER: 22 YEARS [EB]

BONUS

21) EARTH AND SPACE *Short Answer* According to Forchhammer's **[*FOR-chammer*]** Principle, the relative proportions of the six major ions in seawater remain constant despite variations in overall salinity. By name or number, identify all of the following four ions that do not obey Forchhammer's Principle:

1) Iron
2) Magnesium
3) Sulfate
4) Phosphate

ANSWER: 1 AND 4 (ACCEPT: IRON AND PHOSPHATE) [EB]

TOSS-UP

22) MATH *Short Answer* If a paper of 1mm thickness is folded in half, then accordion folded in thirds, then accordion folded in 4ths, then 5ths, and so on, what is the minimum total folds so the paper is at least 1 meter tall?

ANSWER: 21 [MD]

BONUS

22) MATH *Short Answer* Nikesh is making family stickers for cars. A family can be made of up to 4 stickers each of a man, woman, boy, girl, baby, dog or cat, but must have at least one adult. How many different families can there be?

ANSWER: 204 [MD]

TOSS-UP

23) PHYSICS *Short Answer* The lack of a Pauli Exclusion principle for bosons allows them to inhabit what state of matter?

ANSWER: BOSE-EINSTEIN CONDENSATE [AC]

BONUS

23) PHYSICS *Multiple Choice* Which of the following best explains why a large object in an infinite square well does not appear to have quantized observables?

W) Quantum mechanics does not apply at large scales

X) The wave function becomes more dispersed at larger scales

Y) The difference between quantized states are so small that observables are effectively continuous

Z) Probability peaks oscillate too fast for the object to stay in one state

ANSWER: Y) THE OBJECT'S WAVELENGTH IS SO SMALL THAT OBSERVABLES ARE EFFECTIVELY CONTINUOUS [AC]
