Standard Division Double Elimination 5

TOSS-UP

1) BIOLOGY *Short Answer* In order to reach the egg, a sperm must travel through the zona pellucida **[*ZONE-uh peh-loo-SIH-duh*]**. To do this, it releases hydrolytic enzymes from what specialized vesicle?

ANSWER: ACROSOME [GKD]

BONUS

1) BIOLOGY *Short Answer* Identify all of the following three pressures that favor the net movement of water into the nephron:

1) Hydrostatic pressure in Bowman's capsule
2) Hydrostatic pressure in glomerular **[*gluh-MER-you-ler*]** capillaries
3) Osmotic pressure in glomerular capillaries

ANSWER: 2 ONLY (ACCEPT: HYDROSTATIC PRESSURE IN GLOMERULAR CAPILLARIES) [GKD]

TOSS-UP

2) CHEMISTRY *Short Answer* What is the product of the number of radial and angular nodes a 4p electron has?

ANSWER: 2 [GKD]

BONUS

2) CHEMISTRY *Short Answer* The Mond process is one method of purifying nickel. In one step of the process, impure nickel is reacted with carbon monoxide, forming what metal carbonyl coordination complex?

ANSWER: $Ni(CO)_4$ (ACCEPT: TETRACARBONYLNICKEL, NICKEL TETRACARBONYL) [GKD]

TOSS-UP

3) EARTH AND SPACE *Short Answer* By name or number, identify all of the following three types of stars that are often used as standard candles to compute distances to far-away objects?

1) Blue giants
2) Cepheid **[*SEH-fee-id*]** variable
3) RR Lyrae **[*LIE-ray*]** variable

ANSWER: 2 AND 3 (CEPHEID VARIABLE, RR LYRAE VARIABLE) [EB]

BONUS

3) EARTH AND SPACE *Short Answer* What is the name for the extrusive counterpart of granodiorite?

ANSWER: DACITE **[*DA-site*]** [EB]

TOSS-UP

4) MATH *Short Answer* A pool has three drains of different sizes. When only the first drain is open, the pool takes 3 hours to fully drain. When only the second drain is open, the pool takes 4 hours to fully drain. When only the third drain is open, the pool takes 6 hours to fully drain. How long, in minutes, does the pool take to fully drain when all three drains are open?

ANSWER: 80 MINUTES [AKa]

BONUS

4) MATH *Short Answer* If two different words are similar if they share the last 3 letters (in order) and differ in length by 1 or less, how many words are similar to "DUCK"?

ANSWER: 702 [MD]

TOSS-UP

5) PHYSICS *Multiple Choice* A helicopter moves forward at a constant speed and drops a steady stream of sand beneath it. Ignoring air resistance, which of the following best represents how the line of sand will appear in the frame of the helicopter?

W) A straight, vertical line

X) A straight line at an angle and pointing backwards

Y) A curved line pointing backwards

Z) None of these

ANSWER: W) A STRAIGHT, VERTICAL LINE [AC]

BONUS

5) PHYSICS *Short Answer* Akshansh shoots a spitball horizontally at a pig hanging on a string from the ceiling. The 1 gram spitball hits the pig at a velocity of 6 km/s and sticks to it. If the pig weighs 2 kg, how high does it rise during the resulting swing, in meters and to one sig fig?

ANSWER: 0.5 [AC]

TOSS-UP

6) ENERGY *Short Answer* Davidson HS B team members are currently studying autoimmune diseases. In what disease does the immune system attack Schwann cells, preventing myelination in the peripheral nervous system.

ANSWER: GUILLAIN-BARRÉ **[*GEE-on bar-AY*]** (DO NOT ACCEPT: MULTIPLE SCLEROSIS) [GLD]

BONUS

6) ENERGY *Short Answer* Davidson HS A team members are currently studying solid-state chemistry. Rank the following three compounds in order of increasing band gap:

1) Gallium phosphide
2) Aluminum nitride
3) Zinc sulfide

ANSWER: 1, 3, 2 (ACCEPT: GALLIUM PHOSPHIDE, ZINC SULFIDE, ALUMINUM NITRIDE) [GKD]

TOSS-UP

7) BIOLOGY *Short Answer* Since DNA has a negative charge, identify all of the following three amino acids that you would expect to be especially abundant in histone proteins:

1) Arginine **[*AR-jih-neen*]**
2) Threonine **[*THREE-oh-neen*]**
3) Phenylalanine **[*FEE-null-AL-uh-neen*]**

ANSWER: 1 ONLY (ACCEPT: ARGININE) [GKD]

BONUS

7) BIOLOGY *Multiple Choice* Which of the following best describes the difference in photosynthetic efficiency between C_3 and C_4 plants at different CO_2 concentrations?

W) C_3 plants are always more efficient

X) C_4 plants are always more efficient

Y) C_3 plants are more efficient at lower concentrations and C_4 plants are more efficient at higher concentrations

Z) C_4 plants are more efficient at lower concentrations and C_3 plants are more efficient at higher concentrations

ANSWER: Z) C_4 PLANTS ARE MORE EFFICIENT AT LOWER CONCENTRATIONS AND C_3 PLANTS ARE MORE EFFICIENT AT HIGHER CONCENTRATIONS [GKD]

TOSS-UP

8) CHEMISTRY *Short Answer* What particle can destroy hydrogen bonds in organic molecules by tunneling into them?

ANSWER: PROTON [AC]

BONUS

8) CHEMISTRY *Short Answer* To one significant figure and treating the ideal gas constant as 8.314 joules per mole kelvin and the molar masses of carbon and chlorine to be 12 and 35.5 amu respectively, what is the density of a sample of gaseous carbon tetrachloride at 300 Kelvin at a pressure of 5 pascals?

ANSWER: 0.3 [GKD]

TOSS-UP

9) EARTH AND SPACE *Short Answer* Identify all of the following three scenarios that would lead to an increase of primary production in the oceans:

1) Increase of sea surface temperatures
2) Upwelling of colder water
3) Addition of iron

ANSWER: 2 AND 3 (ACCEPT: UPWELLING OF COLDER WATER, ADDITION OF IRON) [EB]

BONUS

9) EARTH AND SPACE *Short Answer* What is the name for the small, spherical inclusions of silicon, oxygen, magnesium, and other elements that are found in many stony meteorites?

ANSWER: CHONDRULES [EB]

TOSS-UP

10) MATH *Short Answer* The position of a robot follows x(t) = -3t^2 + 12t for t greater than or equal to 0. How far has the robot gone when it turns around?

ANSWER: 12 [MD]

BONUS

10) MATH *Short Answer* An isosceles trapezoid ABCD has parallel sides AB and CD with length 5 and 8. Given that BC has length 3, what is the length of AC?

ANSWER: 7 [AKa]

TOSS-UP

11) PHYSICS *Short Answer* An electron moves at $3.2 * 10^{-13}$ m/s perpendicular to a magnetic field with magnitude of $9.11 * 10^{-22}$ Teslas. What is the radius of the orbit that the electron travels in, in meters and to one significant figure?

ANSWER: $2 * 10^{-3}$ [AC]

BONUS

11) PHYSICS *Multiple Choice* Which of the following properties would be least desirable for a dielectric in a supercapacitor?

W) High permittivity

X) High likelihood of ionization

Y) Ability to remain as a solid at room temperature

Z) Easily polarizable

ANSWER: X) HIGH LIKELIHOOD OF IONIZATION [AC]

TOSS-UP

12) ENERGY *Short Answer* Davidson MS A team members are studying quantum mechanical spin. Photon spin can be thought of as what property?

ANSWER: POLARIZATION [AC]

BONUS

12) ENERGY *Short Answer* Davidson MS A Team are learning about Pascal's triangle. Given that 13 choose 11 is 78, 13 choose 10 is 286, 13 choose 9 is 715, and 14 choose 11 is 364, what is 14 choose 10?

ANSWER: 1001 [MD]

TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following statements is false about transcription and its regulation?

W) Enhancers are typically 10 to 100 nucleotides upstream of the genes they regulate

X) Genes encoding for ribosomal proteins would be located in a region of euchromatin **[*YOU-crow-muh-tin*]**

Y) On the template strand, the TATA box is found on the 3' **[**3 ***prime***] end of the gene

Z) The 5' **[**5 ***prime***] cap is a modified form of guanine

ANSWER: W) ENHANCERS ARE TYPICALLY 10 TO 100 NUCLEOTIDES UPSTREAM OF THE GENES THEY REGULATE [GKD]

BONUS

13) BIOLOGY *Short Answer* While reading the plants chapters in Campbell Biology, Griffin suffers an aneurysm and will die if he keeps looking at Campbell. In order to save him, Akshansh pulls him away from the textbook, but in the process catches a glimpse of a diagram on double fertilization, putting him at a 20% risk of getting an aneurysm and dying. Identify all of the following three relationships that Griffin and Akshansh could have that would make it evolutionarily favorable for Akshansh to save Griffin, assuming they will both have two children if they live:

1) Half-brothers
2) Grandfather and grandson
3) First cousins

ANSWER: 1 AND 2 [GKD]

TOSS-UP

14) CHEMISTRY *Short Answer* What law of electrochemistry states that the mass of a substance deposited at an electrode is directly proportional to the charge passed through it?

ANSWER: FARADAY'S FIRST LAW [GKD]

BONUS

14) CHEMISTRY *Short Answer* $H_2PO_4^-$ and HPO_4^{2-} are commonly used as a buffer system in cells. Given that the pKa of $H_2PO_4^-$ is 7.2, if this buffer system is used to keep a peroxisome at a pH of 9.2, and the total concentration of $H_2PO_4^-$ and HPO_4^{2-} in the peroxisome is 0.02 molar, estimate, to one significant figure and in scientific notation, the concentration of $H_2PO_4^-$ in the peroxisome.

ANSWER: 2×10^{-4} [GKD]

TOSS-UP

15) EARTH AND SPACE *Multiple Choice* Which of the following types of fog forms as cold, dry air moves over warm water?

W) Steam fog

X) Upslope fog

Y) Advection fog

Z) Radiation fog

ANSWER: W) STEAM FOG [EB]

(SOLUTION: Advection fog is formed when warm air moves over cold water)

BONUS

15) EARTH AND SPACE *Short Answer* What dune type is composed of ridges that run perpendicular to the prevailing wind direction?

ANSWER: TRANSVERSE [EB]

TOSS-UP

16) MATH *Short Answer* Two points are randomly chosen within a sphere of radius 2 units. Find the probability that at least one of the points is within 1 unit of the sphere's center.

ANSWER: 15/64 [AKa]

BONUS

16) MATH *Short Answer* Megan is operating her penguin blender factory. Each blender costs 5 dollars to make and each penguin costs 8 dollars to make, and there is a daily budget of 2,300 dollars. Each item is made one at a time, with a blender taking 2 minutes to make and a penguin taking 1 minute, and the work day is 8 hours. What is the maximum total number of penguins and blenders that can be made in a day?

ANSWER: 340 [MD]

TOSS-UP

17) PHYSICS *Short Answer* What type of thermodynamic cycle is used by steam turbines and certain steam engines, such as those you would find on Thomas the Tank Engine?

ANSWER: RANKINE [AC]

BONUS

17) PHYSICS *Short Answer* Some imbecile has punched a hole in the bottom of the holiday party punch bowl. Just after the hole is made, liquid flows out of the hole at a velocity v. What factor will v be multiplied by if the height of liquid in the bowl is doubled and the exit hole diameter is halved?

ANSWER: sqrt(2) [AC]
(SOLUTION: rho * g * h = ½ rho * v^2, h is doubled)

TOSS-UP

18) ENERGY *Short Answer* Davidson HS A team members are studying the Equatorial coordinate system. What is the right ascension, in hours, of a star that is located 75 degrees east of the vernal equinox?

ANSWER: 5 [EB]

BONUS

18) ENERGY *Multiple Choice* Davidson HS A Team members are studying common asbestos minerals, including chrysotile **[*KRIH-so-tile*]**, grunerite, and tremolite. Aside from chrysotile, many of these asbestos minerals are members of what family of double-chain inosilicates that are often found abundantly in andesites and diorites?

W) Amphibole **[*AM-fih-bowl*]** group

X) Feldspar group

Y) Pyroxene **[*pi-ROCKS-een*]** group

Z) Tourmaline group

ANSWER: W) AMPHIBOLE GROUP [EB]

TOSS-UP

19) BIOLOGY *Short Answer* Identify all of the following three statements about protists that are true:

1) Diatoms are more closely related to radiolarians than they are to brown algae
2) Algae exhibit alternation of generations
3) Foraminifera **[*for-uh-min-IH-fur-uh*]** have cell walls made of silica

ANSWER: 2 ONLY [GKD]

BONUS

19) BIOLOGY *Short Answer* In plants, the embryo sac contains seven distinct cells with a total of eight nuclei. Order the following three cell types from most to least abundant in the embryo sac:

1) Synergid **[*sih-ner-JID*]** cell
2) Antipodal cell
3) Egg cell

ANSWER: 2, 1, 3 (ACCEPT: ANTIPODAL CELL, SYNERGID CELL, EGG CELL) [GKD]

TOSS-UP

20) CHEMISTRY *Short Answer* Otto Hahn and Lisa Meitner discovered what metastable nuclei that contain nucleons in excited energy states?

ANSWER: NUCLEAR ISOMERS [AC]

BONUS

20) CHEMISTRY *Short Answer* In terms of the gas constant R, what is the difference between molar heat capacity at constant pressure and at constant volume?

ANSWER: R [GKD]

TOSS-UP

21) EARTH AND SPACE *Multiple Choice* Which of the following glacial features are caused by glacial drift abrading into bedrock and producing series of crescent-like scars?

W) Roche moutonnee **[*ROASH MOO-toe-nay*]**

X) Ogives **[*AW-jives*]**

Y) Chatter marks

Z) Eskers

ANSWER: Y) CHATTER MARKS [EB]

BONUS

21) EARTH AND SPACE *Short Answer* By name or number, order the following four moons of jupiter from the one with the largest orbital radius to the one with the shortest orbital radius:

1) Ganymede **[*GAN-ih-meed*]**
2) Europa
3) Callisto
4) Io

ANSWER: 3, 1, 2, 4 (ACCEPT: CALLISTO, GANYMEDE, EUROPA, IO) [EB]

TOSS-UP

22) MATH *Multiple Choice* What is the slope of the line tangent to the graph x squared plus y squared equals twenty-five at the point four comma three?

W) -4/3

X) -3/4

Y) 3/4

Z) 4/3

ANSWER: W) -4/3 [EB]

BONUS

22) MATH *Short Answer* A circular algal bloom grows from the center of a circular lake. The bloom's radius grows at a constant rate. The bloom starts to grow at 1:00 p.m and covers the whole pond by 11:00 p.m.; at what time, to the nearest hour, does the bloom cover half of the pond?

ANSWER: 8 PM [AKa]

TOSS-UP

23) PHYSICS *Short Answer* A pentaquark is an exotic version of what class of hadrons?

ANSWER: BARYONS [AC]

BONUS

23) PHYSICS *Multiple Choice* A mongoose chases a cobra. The mongoose moves at 70% the speed of light and the cobra at 80%. Which of the following is true about how fast the cobra appears to the mongoose?

W) The cobra appears to move at 10% the speed of light

X) The cobra appears to move between 10 and 20% the speed of light

Y) The cobra appears to move between 20 and 30% the speed of light

Z) The cobra appears to move at more than 30% the speed of light

ANSWER: Y) THE COBRA APPEARS TO MOVE BETWEEN 20-30% THE SPEED OF LIGHT (SOLUTION: Exact value is around 0.23C) [AC]
